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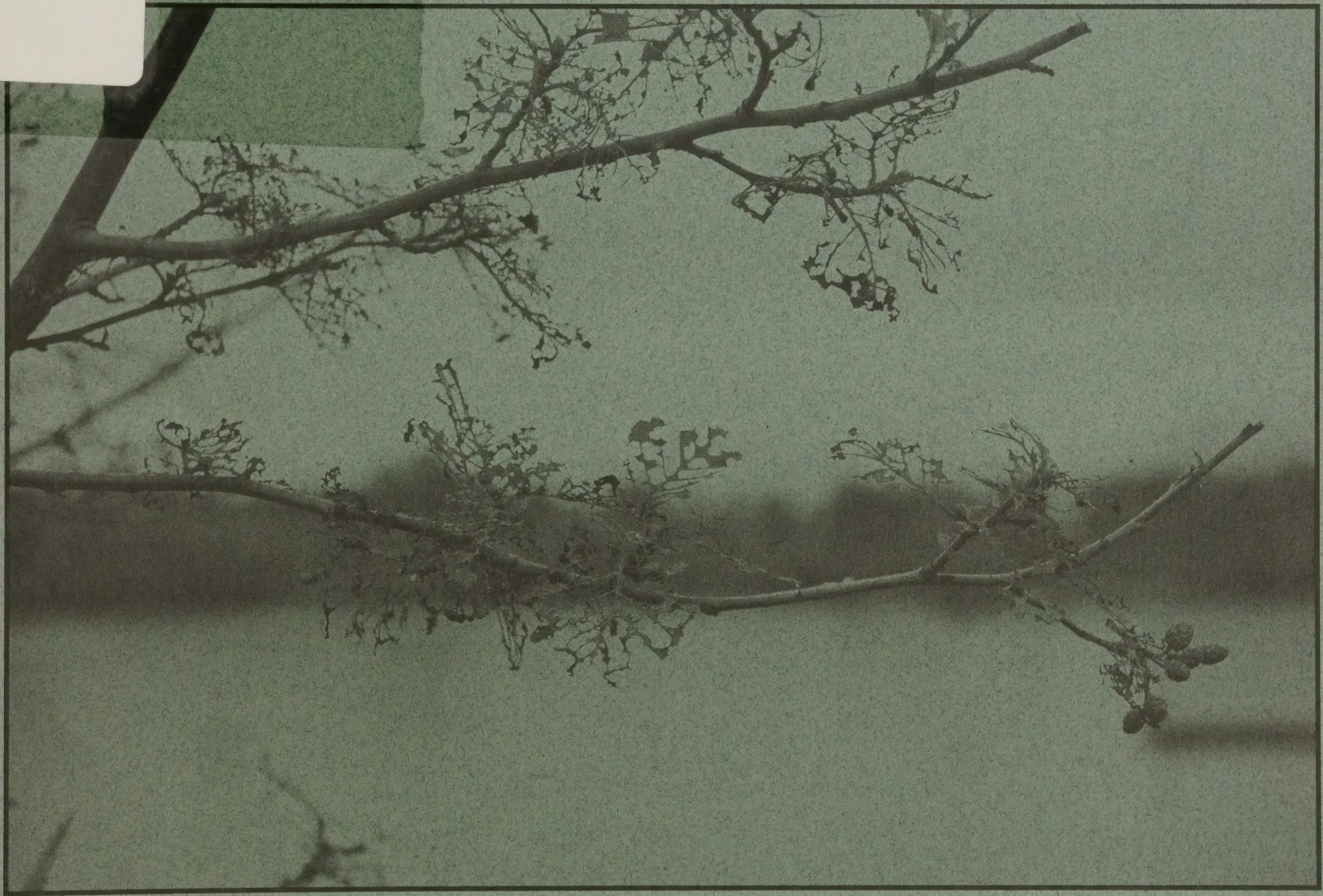
Forest Insect and Disease Conditions in Alaska—2002



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Forest Insect and Disease Conditions in Alaska—2002

General Technical Report R10-TP-113
February 2003

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Conditions in Brief

Aerial detection mapping is conducted annually to document the location and extent of active forest insect and disease damage. Each of these surveys (southeast Alaska, interior Alaska, and south-central Alaska) covers approximately one-fifth of the forested land in the State. Twenty-four million acres throughout Alaska were surveyed in 2002. Insect and disease activity, mapped via aerial surveys, nearly doubled in 2002 over 2001 levels (484,626 acres vs. 266, 299 acres). This significant increase was due to an outbreak of aspen leaf miner near Fort Yukon, in interior Alaska, totaling 300,000 acres.

Insects:

The largest outbreak of aspen leaf miner on record in Alaska was noted approximately 40 miles east of Fort Yukon, between the Yukon and Porcupine Rivers. 271,000 acres of activity were mapped in this area, while 20,000 acres were mapped near Big Delta, and another 6,000 acres of activity between Fairbanks and Minto. In most cases, this activity is classified moderate to heavy.

Three areas of significant birch leaf roller activity were mapped this year. 30,000 acres of heavy leaf roller activity was found in the Wood River–Tikchik Lakes State Park, north of Dillingham; 15,000 acres of moderate activity near Mt. Susitna, 50 miles northwest of Anchorage and; 6,000 acres of light activity 20 miles east of Lake Minchumina.

Leaf roller defoliated cottonwood on 5,287 acres along the shores of Russell Fiord and Yakutat Forelands. Another 8,849 acres of cottonwood were defoliated in Glacier Bay National Park.

Spruce beetle activity declined statewide by 50 percent over 2001 levels, to only 52,000 acres; the lowest level in more than thirty years. The activity at Lake Iliamna accounted for one-half of this total. This follows an epidemic, over decade long, that eliminated the majority of beetle host material (white spruce) on over 4 million acres. Spruce beetle is still active in several other areas, most notably McCarthy, the Kenai Peninsula, and near White Mountain on the Seward Peninsula. Throughout the remainder of the state, with the exception of a few small, active areas, spruce beetle populations have fallen to endemic or near-endemic levels. The outbreak on the Haines State Forest continues to collapse with less than 300 acres mapped in 2002.

The **willow leaf miner** infestation in the Yukon Flats area of northeastern interior Alaska has subsided to nearly undetectable levels. This infestation impacted hundreds of thousands of acres in this area over a span of more than 10 years. In its wake, a considerable, though unquantified amount of willow mortality, attributed to years of severe impact by this leaf miner, remains.

Amber-marked birch leaf miner populations once again exploded in the Anchorage Bowl. More than 30,000 acres of heavily defoliated birch were detected this year. This introduced insect has now spread north and south of Anchorage and was recently introduced into the Fairbanks area. Investigation to consider biological control opportunities of this potentially significant and newly introduced pest are underway.

Spruce aphid defoliation in southeast Alaska occurred on approximately 2,300 acres in southeast Alaska from Dall Island on the south end of Alexander Archipelago to Skagway. Most of the defoliation occurred on National Forest lands (1,640 acres) on the outside islands from Heceta Island south to Port Bazan, Dall Island, and along Lynn Canal to Skagway. Spruce aphid defoliation was virtually absent from the Juneau, Sitka, Ketchikan, and Wrangell Boroughs.

In 2002, **black-headed budworm** activity was mapped on 3,400 acres, down significantly from 2001 levels of approximately 51,000 acres. Nearly all of this acreage was mapped in Prince William Sound.

Hemlock sawfly occurred on 1,400 acres, most of it south of Sumner Strait. Much of hemlock sawfly defoliation, 1000 acres, occurred where it commonly occurs, on the southwest end of Kosciusko Island on state (600 acres) and National Forest (400 acres) lands.

Diseases:

The most important diseases and declines of Alaskan forests in 2002 were wood decay of live trees, root disease of white spruce, hemlock dwarf mistletoe, and yellow-cedar decline. Except for yellow-cedar decline,

trees affected by these diseases are difficult to detect by aerial surveys. Nonetheless, all are chronic factors that significantly influence the commercial value of the timber resource and alter key ecological processes including forest structure, composition, and succession. Wildlife habitat is enhanced through the development of hollow tree cavities by heart rot fungi, and witches' brooms by hemlock dwarf mistletoe and broom rust fungi.

In southeast Alaska—approximately one-third of the gross volume of forests is defective due to **stem and butt rot fungi**. **Hemlock dwarf mistletoe** continues to cause growth loss, top-kill, and mortality in old-growth forests; its impact in managed stands depends on the abundance of large infected trees remaining on site after harvesting.

Nearly 500,000 acres of **yellow-cedar decline** have been mapped across an extensive portion of southeast Alaska. In 2002, areas of particularly active mortality to yellow-cedar were observed on about 3,000 acres scattered across southeast Alaska, with the most numerous areas being in Peril Strait, western Baranof Island and southwest Chichagof Island. Snags of yellow-cedar accumulate on affected sites and forest composition is substantially altered as yellow-cedar trees die, giving way to other tree species. The wood in dead standing trees remains valuable long after tree death and salvage opportunities for this resource are now being recognized.

Cone and other **foliar diseases** of conifers were generally at low levels throughout Alaska in 2002. **Canker fungi** were at endemic levels, causing substantial, but unmeasured, damage to hardwood species in south-central and interior Alaska. Canker fungi on conifers, particularly on western hemlock and subalpine fir occurred at higher than normal levels and caused branch dieback in southeast Alaska.

In south-central and interior Alaska—**tomentosus root rot** continues to cause growth loss and mortality of white spruce in all age classes. Various **stem and butt rot fungi** cause considerable defect in mature white spruce, paper birch and aspen stands. **Saprophytic decay** of spruce bark beetle-killed trees, primarily caused by the red belt fungus, continues to rapidly develop on and degrade dead spruce trees.

A late spring **frost** damaged vegetation throughout southeast Alaska in 2002. Many conifers species and evergreen broadleaf plants expressed shoot dieback as the result of warm spring temperatures followed by a cold spell in early April.

Invasive Organisms:

Insects and Arthropods:

In the past several years, several exotic pest introductions have been detected in the Anchorage area. In 2002, the **amber-marked birch leaf miner** (newly described in 2002), **uglynest caterpillar**, and the **European black slug** were all reported in Alaska. The amber-marked birch leaf miner caused heavy birch defoliation throughout Anchorage. This defoliator is the larval form of a sawfly. These invasive pests and others may become established throughout Alaska if detection and eradication methods are not employed early. Primary detection of these introductions has been through the Integrated Pest Management Program sponsored by the USDA Forest Service and administered by the Alaska Cooperative Extension.

Plants:

Several species continue to spread into different areas of the state. **White sweet clover**, *Melilotus alba*, occupies hundreds of acres along the Stikine River in southeastern Alaska, and is now showing up on the Nanana River in the interior. **Bird vetch**, *Vicia cracca*, is widely distributed in southern Anchorage, the Matanuska Valley, and in portions of Fairbanks. A new species of noxious weed for Alaska is **garlic mustard**, *Alliaria petiolata*, which was first found in Alaska in 2001. This new infestation is located just below the Governor's mansion in Juneau. Thousands of plants were collected at this sole known infection site to prevent seed set in 2002.

Several other species are being mapped across the State. Interagency an interest group inventories are being coordinated for consistency and entered into a statewide GIS inventory base. As a result of these coordination efforts, cooperative control projects are expected to increase to address these relatively newly recognized forest health threats to Alaska resources.

Table 1. 2002 forest insect and disease activity as detected during aerial surveys in Alaska by land ownership[1] and agent[2]. All values are in acres.

Damage Agent	National Forest	Native Corp.	Other Federal	State & Private	Total 2002
Alder Defoliation[3]	1,159	502	113	75	1,848
Aspen Leaf Miner		66,871	128,115	104,482	299,468
Birch Leaf Miner		310	159	29,702	30,171
Birch Leaf Roller		9,384	6,060	37,380	52,824
Black-headed Budworm	2,494	334	2	524	3,354
Cedar Decline Faders[4]	2,835	39	8	150	3,033
Cottonwood Defoliation[5]	3,842	38	14,640	1,337	19,857
Hemlock Canker	230			9	239
Hemlock Sawfly	743			612	1,355
Ips Engraver Beetle	32	379	601	241	1,253
Larch Beetle			4,849		4,849
Large Aspen Tortrix			2,197	283	2,480
Spruce Aphid	1,640	127	32	537	2,336
Spruce Beetle	2,133	23,692	13,406	13,157	52,388
Spruce Budworm		943		4,239	5,182
Spruce Needle Cast		1,277	2,236		3,513
Sub Alpine Fir Beetle	8			204	212
Willow Defoliation[3]			62	203	265
Total Acres	15,116	103,896	172,480	193,135	484,627

[1]Ownership derived from 2002 version of Land Status GIS coverage, State of Alaska, DNR/Land records Information Section. State & private lands include, state patented, tentatively approved or other state acquired lands, of patented disposed federal lands municipal or other private parcels.

[2]Table entries do not include many of the most destructive diseases (e.g., wood decays and dwarf mistletoe) these losses are not detectable in aerial surveys.

[3]Significant contributors include leaf miners and leaf rollers for the respective host.

[4]Acres represent only spots where current faders were noticed. Cumulative cedar decline acres can be seen in Table 6.

[5]Significant contributors include cottonwood leaf beetle and leaf rollers.

Table 2. Affected area (in thousands of acres) for each host group and damage type over the prior five years and a 10-year cumulative sum.

Host Group / Damage Type[1]	Prior Five Years (thousand acres) 1997	1998	1999	2000	2001	2002	Ten Year Cumulative[2]
Alder Defoliation	0.0	0.8	1.8	5.6	1.2	1.8	11.2
Aspen Defoliation	5.1	21.9	13.4	12.6	9.4	301.9	522.1
Birch Defoliation	271.9	0.7	2.8	2.8	3.2	83.0	375.2
Cottonwood Defoliation	3.0	6.6	5.6	5.4	9.9	19.9	61.2
Hemlock Defoliation	6.6	3.9	0.1	5.2	1.3	1.4	35.4
Hemlock Mortality	0.0	0.0	0.0	0.0	0.1	0.2	0.6
Larch Defoliation	267.9	461.8	159.5	64.9	17.8	0.0	1,556.6
Larch Mortality	0.0	0.0	18.4	0.0	0.0	4.8	23.5
Spruce Defoliation	49.7	136.0	5.1	84.7	61.1	11.0	814.9
Spruce Mortality	569.4	331.0	258.0	120.9	104.2	53.6	2,630.3
Spruce/Hemlock Defoliation	30.8	0.0	0.1	0.0	50.7	3.4	460.2
Spruce/Larch Defoliation	0.3	0.0	0.0	0.0	0.0	0.0	16.8
Sub Alpine Fir Mortality	0.0	0.0	0.0	0.0	0.1	0.2	0.3
Willow Defoliation	3.5	123.2	181.6	36.5	10.9	0.3	428.6
Total thousands acres	1,208.2	1,085.9	646.4	338.6	269.9	481.5	6,936.9

[1]Summaries here identify damage mostly from insect agents. Foliar disease agents contribute to the spruce defoliation and hemlock mortality totals. Damage agents such as fire, wind, flooding, slides and animal cause damage are not included. Cedar mortality is summarized in Table 6.

[2]The same stand can have active infestation for several years. The cumulative total is a union of all areas from 1993 through 2002.

The Role of Disturbance in Ecosystem Management

Forests may appear static to the casual forest user, but in fact, most forests are in some stage of re-establishment after one or more disturbances. In Alaska, geological processes, climatic forces, insects, plant diseases, and the activities of animals and humans have shaped forests. To consider the management and sustainability of these ecosystems, we must understand how these cycles of disturbances have shaped and continue to influence the forest's structure and ecological functions.

Disturbances result in changes to ecosystem function. In forests, this often means the death or removal of trees. Disturbances caused by physical forces such as volcanoes, earthquakes, storms, droughts, and fire can affect the entire plant community, although some species may be more resistant to damage than others. Insects, plant diseases, animal and human activities are usually more selective, directly affecting one or several species.

Cycles of disturbance and recovery repeat over time and across landscapes. From evidence of past disturbances on a landscape, we can predict what type of disturbance is likely to occur in the future. Landscapes supporting large areas of single age stands indicate rare, but intense large-scale disturbances. Landscapes with a variety of age classes and species suggest more frequent smaller scale events. Usually, several types of disturbances at various scales of space, time, and intensity have influenced forest structure and composition on a given site. The role of disturbance in ecological processes is well illustrated in Alaska's two distinct forest ecosystem types and transition zones.

The temperate rain forests of southeast Alaska are dominated by western hemlock. Sitka spruce, Alaskan yellow-cedar, western red cedar, shore pine and mountain hemlock are also important components of the forest. Along the mainland part of SE Alaska black cottonwood, and paper birch appear in small amounts. Trees on productive sites can attain great size due to abundant rainfall and moderate temperatures. Wind is the major disturbance agent in southeast. Degree of impact and scale depends on stand composition, structure, age and vigor and as well as wind speed, direction, duration and topographic effects on wind flow. The forest type most susceptible to wind throw is mature spruce or hemlock on productive, wind-exposed sites. The large, top-heavy canopies act as sails and uprooting is common, resulting in soil churning, which expedites nutrient cycling and increases soil permeability. Even-aged forests develop following large-scale catastrophic wind events. Old-growth forest structure develops in landscapes protected from prevailing winds. In these areas, small gap-forming events dominate. Trees are long-lived, but become heavily infected with heart-rot fungi, hemlock dwarf mistletoe, and root rot fungi as they age. Weakened trees commonly break under the stress of gravity and snow loading. Canopy gaps generated this way do not often result in exposed mineral soil.

Figure 1. *Wind disturbance is a common precursor to other forms of disturbance such as bark beetles, fire, and landslides.*

The boreal forests of interior Alaska are comprised of white spruce, black spruce, paper birch, quaking aspen, balsam poplar and tamarack. The climate is characterized by long, cold winters, short, hot summers, and low precipitation. Cold soils and permafrost limit nutrient cycling and root growth. Topographic features strongly influence microsite conditions; north-facing slopes have wet, cold soils, whereas south-facing slopes are warm and well drained during the growing season. Soils are usually free from permafrost along river drainages, where flooding is common. Areas more distant from rivers are usually underlain by permafrost and are poorly drained. Fire is the major large-scale disturbance agent; lightening strikes are very common. All tree

species are susceptible to damage by fire, and all are adapted, to various degrees, to regeneration following fire. Fire impacts go beyond removal of vegetation; depending on the intensity and duration of a fire, soil may be warmed, upper layers of permafrost may thaw, and nutrient cycling may accelerate. Patterns of forest type development across the landscape are defined by the basic silvics of the species involved. Hardwoods are seral pioneers, resprouting from roots or stumps. White spruce stands are usually found on better-drained soils, along flood plains, river terraces, and on slopes with southern exposure. Black spruce and tamarack occur in areas of poor drainage, on north-facing slopes, or on upland slopes more distant from rivers where permafrost is common.

South-central Alaska is a transition zone between the coastal marine climate of southeast and the continental climate of the interior. These forest communities are more similar to those in the interior, except where Sitka spruce and white spruce ranges overlap and the Lutz spruce hybrid is common. Fire has been a factor in the forest landscape patterns we see today. These fires, however, were mostly the result of human activity; lightning strikes are uncommon in the Cook Inlet area. Major disturbances affecting these forests in the past century have been human activity and spruce beetle caused mortality. Earthquakes, volcanic eruptions, and flooding following storm events have also left significant signatures on the landscape.

Disturbances play an important role in shaping forest composition, structure, and development. With knowledge of disturbance regimes, managers can understand key processes driving forest dynamics and gain insight into the resiliency (the ability to recover) and resistance (the ability to withstand change) of forests to future disturbance. As we improve our understanding of the complexities of these relationships, we are better able to anticipate and respond to natural disturbances and mimic the desirable effects with management activities. Ecological classification is one tool available to help us understand disturbance patterns.

Several useful systems of classification have been developed for Alaska's ecosystems and vegetation. Field and resource specialists representing a variety of organizations, including representatives from Canada, came together and delineated ecoregions based on climate, phsyiography, vegetation, and glaciation.

In Alaska, three distinct climatic-vegetation regimes exist representing polar, boreal, and maritime. These regimes cover broad areas and grade from one to another across the state (see map on following page). To accommodate this spatial arrangement, ecoregion groups were arranged in a triangular manner reflecting the major regimes and gradations between them (see the following figure). Through this projection (a triarchy), the natural associations among ecoregion groups are displayed as they occur on the land without loss of information (i.e., retains the spatial interrelations of the groups). An ecoregion map can be seen on the following page and ecoregion descriptions can be found at http://agdc.usgs.gov/data/projects/fhm/.

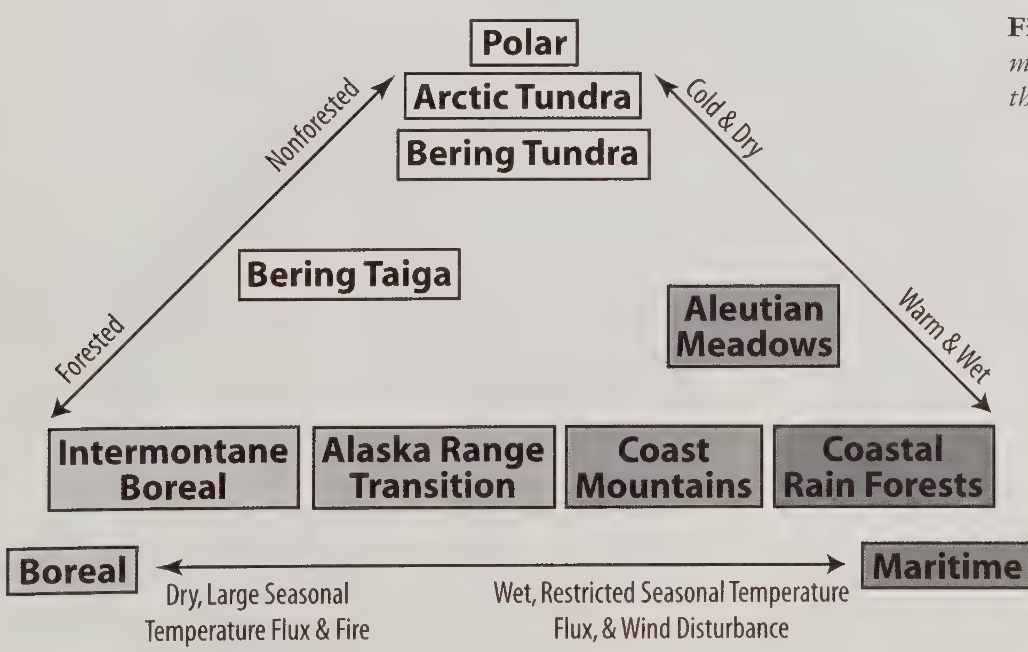
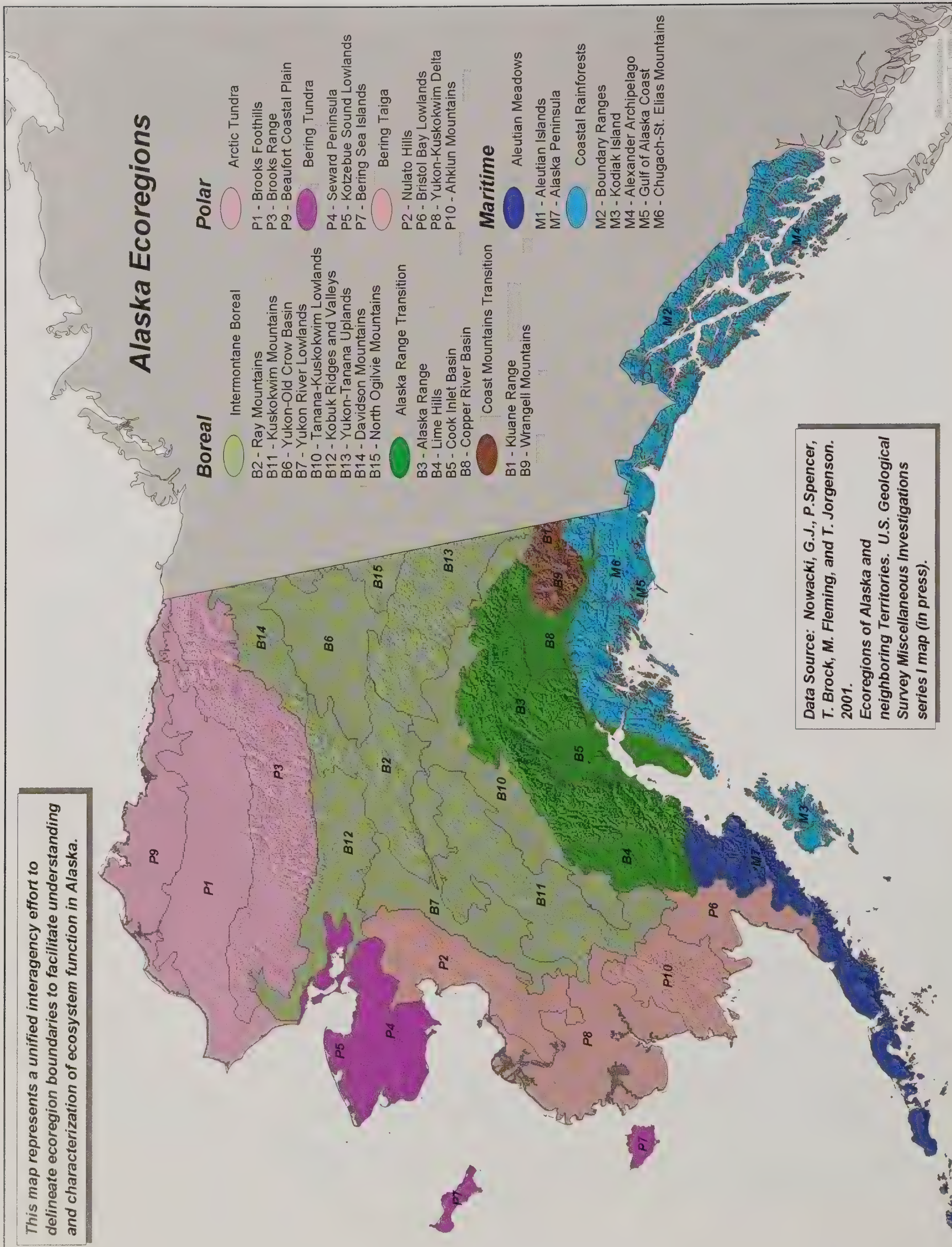


Figure 2. *This triarchy illustrates the major regimes and gradations between the Alaska ecoregions.*

Map 1. Ecoregion Map



Status of Insects

Bark Beetles

Bark Beetles as Agents of Disturbance

Insects are active and significant components of Alaska's ecosystems. Arctic–boreal insects are characterized by having few species and large population numbers. Boreal insects are opportunistic in their behavior. They respond quickly to changes in climate and the availability of food and breeding material. Spruce beetles, for example, are one of the most important disturbance agents in mature white spruce stands in south-central and interior Alaska. The spruce beetle responds quickly to large-scale blowdown, fire-scorched trees, and spruce injured by flooding. Large numbers of beetles can be produced in such breeding material, leading to potential outbreaks.

A variety of changes occur to forest resources when many trees are killed. In the long run these changes are biological or ecological in nature. There are also socioeconomic consequences in the short term that can be viewed as either positive or negative, depending on the forest resource in question. Some of the impacts associated with spruce beetle infestations include, but are not limited to:

- **Loss of merchantable value of killed trees**: The value of spruce as saw timber is reduced within three years of attack in south-central Alaska due to weather checking and sap-rots. The value of beetle-killed trees as house logs, chips, or firewood continues for many years if the tree remains standing.
- **Long-term stand conversion**: The best regeneration of white and Lutz spruce and birch occur on a seedbed of bare mineral soil with some organic material. Site disturbances such as fire, windthrow, flooding, or ground scarification provide excellent sites for germination and establishment of seedlings if there is an adequate seed source. However, on some sites in south-central Alaska, grass and other competing vegetation quickly invade the sites where spruce beetles have "opened up" the canopy. This delays re-establishment of tree species. Regeneration requirements for Sitka spruce are less exacting; regeneration is thus, less problematic.
- **Impacts to wildlife habitat**: Wildlife populations, which depend on live, mature spruce stands for habitat requirements may decline. We expect to see decreases in red squirrels, spruce grouse, Townsend Warblers, Ruby-crowned kinglets, and possibly Marbled Murrelet populations. On the other hand, wildlife species (moose, small mammals and their predators, etc.) that benefit from early successional vegetation such as willow and aspen may increase as stand composition changes.
- **Impacts to scenic quality**: Scenic beauty is an important forest resource. It has been demonstrated that there is a significant decline in public perception of scenic quality where spruce beetle impacted stands adjoin corridors such as National Scenic Byways. Maintaining or enhancing scenic quality necessitates minimizing impacts from spruce beetle infestations. Surveys have also shown that the public is evenly divided as to whether spruce beetle outbreaks damage scenic quality in backcountry areas.
- **Fire hazard**: Fire hazard in spruce beetle impacted stands will increase over time. After a spruce beetle outbreak, grass or other fine vegetation increases and fire spreads rapidly through these vegetation types. As the dead trees break or blow down (5–10 years after an outbreak), large woody debris begins to accumulate on the forest floor. This material (boles) is the largest component of the fuels complex. Heavy fuels do not readily ignite, but once ignited they burn at higher temperatures for a longer period. The combination of fine, flashy fuels and abundant large woody debris results in a dangerous fire behavior situation. Rate of fire spread may increase as well as burn intensity. Observations from recent fires on the Kenai Peninsula have shown an increase in crown fires. This fire behavior is caused by fire traveling up the dead spruce trees and spotting into the crowns of adjacent beetle killed trees.
- **Impact to fisheries**: If salmon spawning streams are bordered by large diameter spruce and these trees are subsequently killed by spruce beetles, there is a concern as to the future availability of large woody debris in the streams. Large woody

debris in spawning streams is a necessary component for spawning habitat integrity.

- **Impact to watersheds**: Intense bark beetle outbreaks can kill large amounts of forest vegetation. The "removal" of significant portions of the forest will impact to some degree the dynamics of stream flow, timing of peak flow, etc. There have been no hydrologic studies in Alaska quantifying or qualifying impacts associated with spruce beetle outbreaks. Impact studies, however, have been done elsewhere. In Idaho watersheds impacted by the Mountain Pine Beetle, there was a 15 percent increase in annual water yield, a 2–3 week advance in snowmelt, and a 10–15 percent increase in low flows.

There are a variety of techniques that can be used to prevent, mitigate, or reduce impacts associated with spruce beetle infestations. Before pest management treatment options can be developed, the forest manager must evaluate the resource values and economics of management actions for each stand in light of management objectives. The beetle population level must also be considered because population levels will determine the priority of management actions and the type of strategy to be invoked. The key to sustainable forest ecosystems is to manage vegetation patterns in order to maintain species diversity, both plant and animal, while providing for a multitude of resources such as recreation, fisheries, wildlife, and the production of wood fiber. Properly applied silvicultural practices as well as fire management in south-central and interior Alaska can maintain the forest diversity needed to provide the range of products and amenities available in the natural forest for now and in the natural forest for now and in the future.

Figure 3. *In some areas, the spruce bark beetle has killed nearly all the spruce trees.*

Spruce Beetle

Dendroctonus rufipennis Kirby

The spruce beetle epidemic that has taken such a heavy toll on south-central Alaska forests for almost two decades appears to have run its course. During that time it is estimated over 4 million acres have been impacted, while in just the last decade, an accumulated 2.63 million acres of spruce forests have been impacted by this beetle (see Table 2 "spruce mortality"). Spruce beetle populations have mostly returned to endemic levels (i.e., less than 1 tree per acre of recent activity) across the state, although localized intensive activity can be expected to continue in some previously impacted areas. There also remains the potential for expansion to new areas of susceptible large-diameter spruce depending on climatic, natural and man-caused disturbance factors. Large areas of susceptible spruce remain for expansion of future bark beetle outbreaks, particularly along the lower Yukon River system, in the Lake Clark region (north of Iliamna), Wood–Tikchik region, portions of the Kenai Peninsula, and the Tanana basin.

Total area of active infestations by spruce bark beetles decreased in 2002 over 2001 totals, from 86,038 to 52,388 acres (a 39 percent reduction), a consistent pattern since the peak of spruce beetle activity statewide in 1996 (1.13 million acres—refer also to Tables 1 & 2). As reported in earlier insect and disease conditions reports, spruce beetle infestations remain active in several areas of the State although as very small, localized infestations. Stands that have been previously undisturbed and/or are adjacent to ongoing infestations, provide a continual source of suitable breeding material for the beetle. That is not the case on over 85 percent of the previously active infestation areas, and especially so in interior Alaska north of the Alaska Range and southeast Alaska panhandle. Spruce beetle activity is expected to persist in these areas until weather conditions, lack of adequate host material, or other disturbances reduce their populations. Vast areas of the state have been rendered unsuitable for further, large-scale beetle activity due to changes in stand structure, loss of host material, or forest-type conversion. Within these areas, beetle populations, for

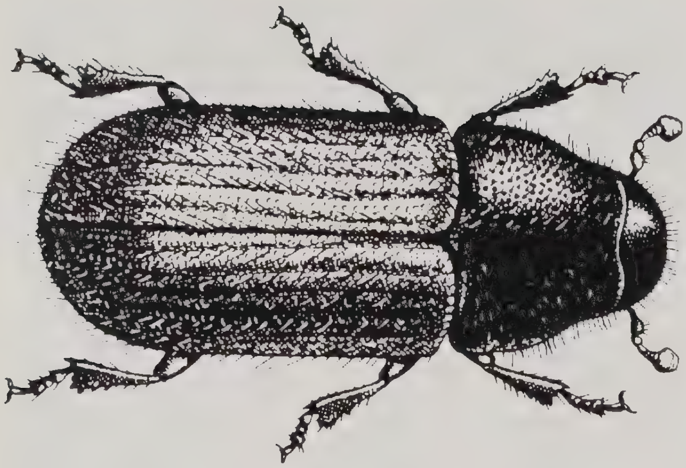


Figure 4. *Spruce bark beetle adult.*

the most part, have been reduced to endemic levels. These same areas, however, still remain at moderate to high risk for potential catastrophic wildfire due to the large volume of beetle-killed spruce timber, both standing-dead or on the ground. Much of the Copper River Valley, Kenai Peninsula, and the west side of Cook Inlet fall into this category.

In 2002, significant, active infestations continue in the Iliamna Lake, Eastern Kenai Peninsula (near Skilak Lake, within Chugach National Forest), Western Kenai Peninsula (Skilak Lake to Tustumena Lake, Upper Kenai River to Funny River, Kachemak Bay to Seldovia, Homer to Anchor Point), Homer-Anchor Point along Cook Inlet, McCarthy, and within the Municipality of Anchorage (valleys along the road system from Girdwood to Eklutna Lake). Lesser (in terms of acres impacted) activity occurs along the Kuskokwim River, Copper River Valley, interior Alaska north of the Alaska Range, and a few very localized areas of northern and southern south-east Alaska.

Lake Iliamna

Spruce beetle activity in the Lake Iliamna area remained static in 2002. 25,691 acres of active infestations were reported, only 900 more acres than were reported in 2001. The infested areas remain essentially the same as they were in 2001 as well, namely the south shore of the lake between Tommy Point and Old Iliamna Village, Pile River, and Pedro/Knutson Bays. At the request of the Pedro Bay Village Council, Forest Health Protection personnel conducted ground surveys in the Pedro Bay/ Knutson Bay areas in May 2002. These surveys indicated a general westward movement of beetle activity from Lonesome Bay, where the beetle has been active for a number of years and has killed nearly all susceptible spruce, toward Pedro Bay Village and Knutson Bay. The gradient of activity is from heavy kill in the east, to moderate activity around Pedro Bay, to light activity at Knutson Bay in the west. Further, surveys found the beetle to be quite active in Pedro Bay and Knutson Bay where numerous new beetle attacks were found. These newly attacked trees will not show obvious evidence of attack until next year. Though beetle activity along the south shore of the lake and at Pile River should decline by next year due to loss of most of the susceptible host material, the intensity of the infestation around Pedro Bay/Knutson Bay should increase for the next several years. There will be little opportunity for the beetle to move much further west of Knutson Bay as spruce becomes widely scattered west of Knutson Bay.

Kenai Peninsula

The Kenai Peninsula is one of two major areas (also Copper River Valley) impacted by the spruce beetle epidemic of the 1990s. The intensity of this epidemic was so severe that in many locations essentially all white spruce of such size to be suitable host material (existing or near future) were killed. This elimination of live forest cover has rendered vast acreage in these areas unsuitable for further insect activity until such time as a new forest is established and grows to a size that will again provide reasonable host material. In many areas this is estimated to be decades.

Across the Kenai Peninsula, including the Chugach National Forest, the south side of Kachemak Bay and the remainder of the mainland Peninsula, total acres of active beetle activity fell from 27,051 acres in 2001 to 8,076 acres in 2002, a 70 percent decline. 2002 Kenai Peninsula spruce beetle activity observed on the Chugach National Forest totaled 3,579 acres vs. 1,860 acres mapped in 2001: 1,350 acres of scattered "heavy" pockets through the Sixmile and Resurrection Creek drainages; 500 acres south of the Seward Highway from East Fork Sixmile River to Granite Creek/Johnson Pass; 701 acres in the Trail Creek to Upper Placer valleys; 25 acres at Grant Lake; and 1,003 acres along the lower end of Kenai Lake from Sheep Mt. to Lost Lake. The current pattern of beetle activity within the Chugach National Forest will likely continue if the pattern of warm, dry late spring and early summer weather continues into 2003 in south-central Alaska. Overall, spruce beetle populations are at endemic levels within the Chugach NF, however,

continued, smaller-scale beetle activity will persist in areas where suitable host material remains or where new areas of disturbance (e.g., powerline or right-of-way clearing, wind-caused stem breakage, salvage harvest) present beetles with the opportunity for periodic population increases. Across the remainder of the Kenai Peninsula, and Kachemak Bay, 2002 beetle activity was mapped at 4,498 acres, concentrated on the south side of Kachemak Bay (1,424 acres) and western Peninsula from Homer to Point Possession (3,074 acres). This is a significant reduction in beetle activity that was mapped at 10,280 acres and 14,823 acres for the areas on the south side of Kachemak Bay and western Kenai Peninsula, respectively, in 2001. Kenai Peninsula spruce beetle activity outside the Chugach NF in 2002: Peterson Bay, 37 acres; 384 acres on Yukon Island; 46 acres from McKeon Flats to Sadie Cove; 16 acres of spotty activity from Jakolof Bay to Seldovia; Kenai River from Skilak Lake to Funny River, 45 acres; Killey River drainage, 1,600 acres; Skilak Lake lowlands southerly to Killey River, 1,410 acres; North side of Tustumena Lake, 35 acres; Northern Peninsula west of Chugach Range from Sterling Highway to Point Possession, 40 acres. Spruce beetle populations have significantly decreased over the past 6 years on the Peninsula as a general trend, due to significant reductions in available host material to sustain the initial epidemic. Areas with the most potential for continuing beetle activity are the Kenai lowlands along Cook Inlet from Kenai to Homer, the upper Kenai River drainage, the Chugach National Forest west of Prince William Sound, and the south side of Kachemak Bay from Sadie Cove to Seldovia and English Bay. These areas have ample uninfested large-diameter host material and will flare up again if favorable climatic conditions occur to ensure brood survival and/or site disturbances are not closely monitored and mitigated in a timely manner.

Northern Interior Alaska

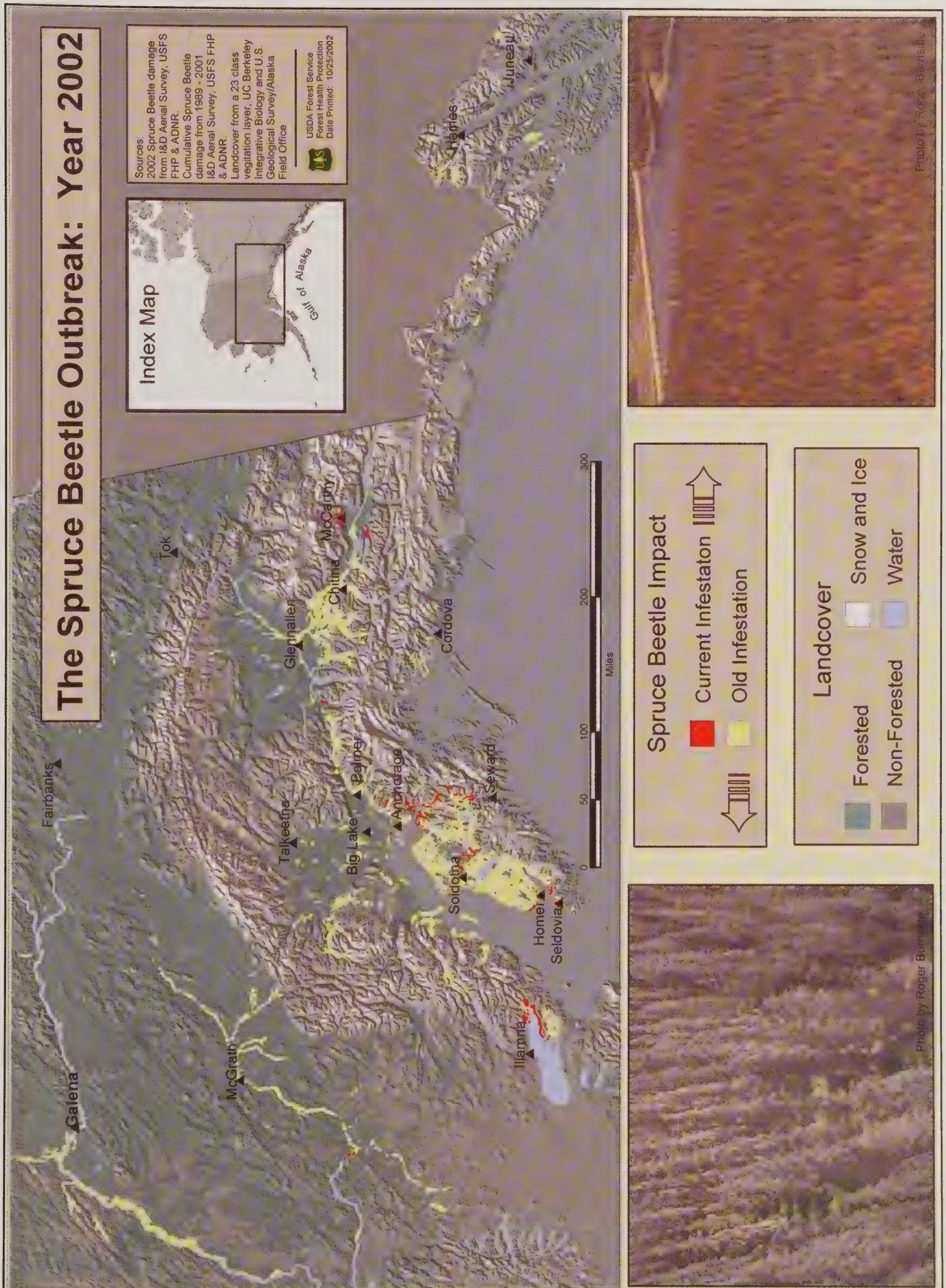
Spruce beetle activity in interior Alaska north of the Alaska Range continues at very low levels with the exception of small, localized infestations (see also Seward Peninsula below). Beetle activity was mapped along the lower Kuskokwim River near Sleetmute (1,486 acres) below McGrath (67 acres), and the Kobuk River west of Bettles (52 acres). Federal national parks personnel traveling the Tanana River between Old Minto and the mouth of the Kantishna River during late summer and early fall reported heavy pockets of beetle-infested spruce along the floodplain. Recent bark beetle activity (fading trees) was not observed during the July aerial surveys suggesting that this outbreak is very new. An inspection will be made in early 2003 to determine a definitive causal agent for this damage. Past spruce beetle outbreaks have been associated with other bark beetles (e.g., the northern spruce engraver, *Ips perturbatus*) and periodic flooding events along these lowland white spruce areas. Bark beetle activity may continue in these northern interior floodplain stands on a more frequent time interval reflecting changing patterns of natural disturbances that impact bark beetle populations (e.g., significant seasonal hydrologic events, changes in seasonal weather cycles, factors that stress host trees).

Seward Peninsula

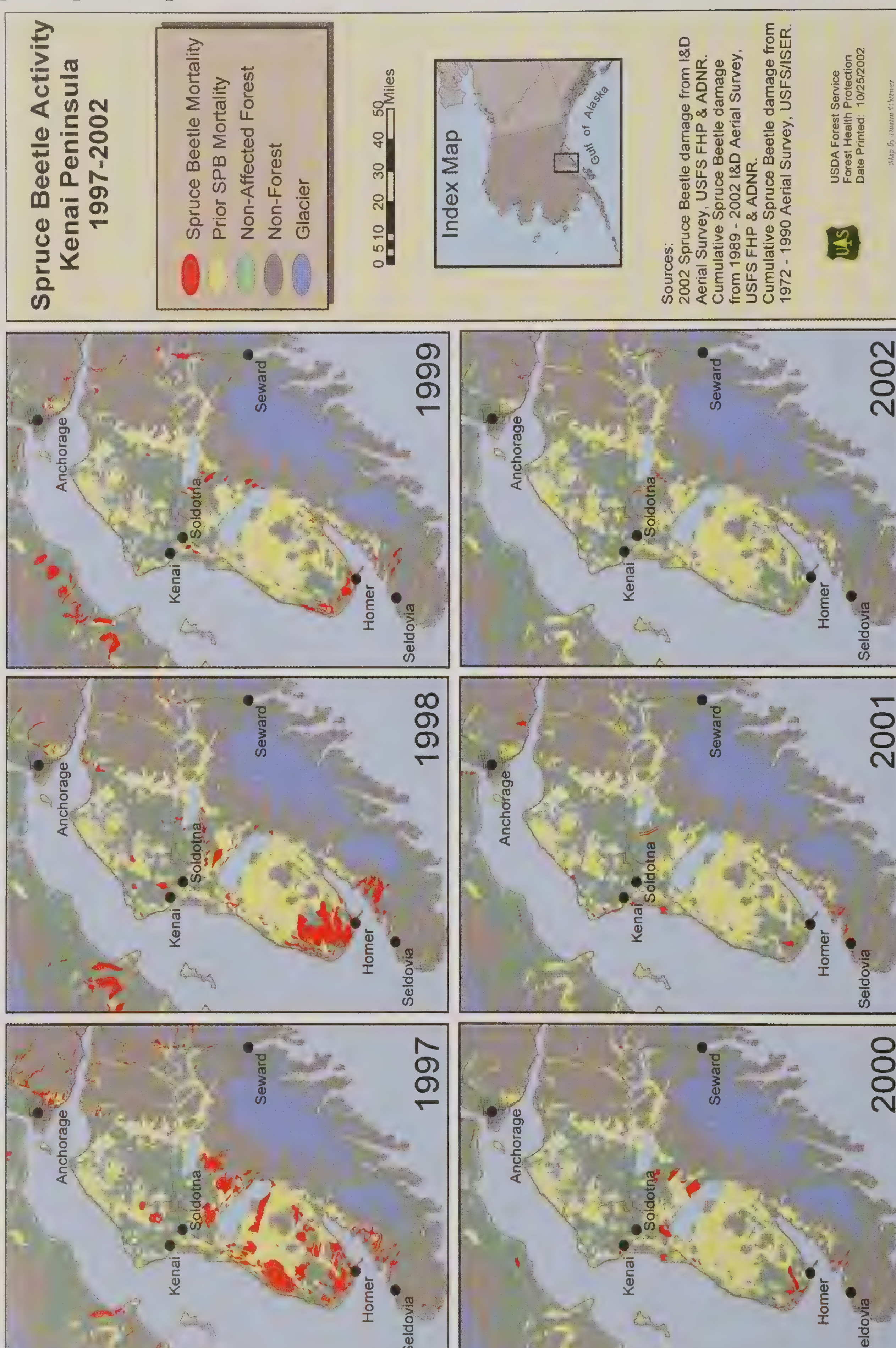
At the village of Elim, on Norton Bay, spruce beetle has been active for several years. Approximately 900 acres of light to moderate activity is ongoing around Elim. Much of the susceptible host material has been killed and beetles remain active in the residual stands. Low-level but continued activity is expected in these stands for the next few years. Nearly 300 acres of activity was observed between the Kachauik and Yuonglik Rivers about 10 miles east of White Mountain. This infestation is confined by the "island" nature of these stands. Discreet stands of mature spruce are scattered throughout the tundra in this area. Little further activity is expected here. The largest portion (~3,000 acres) of activity on the Seward Peninsula is occurring along the Fish River north of White Mountain. Most of this activity should be considered light i.e. 1–2 trees/acre. This infestation has been ongoing for several years, though first observed in 2002. Again, due to the

Figure 5. *Gallery patterns from the spruce bark beetle.*

Map 2. The Alaska Spruce Beetle Outbreak: Year 2002.



Map 3. Sequential spruce beetle effect, 1997–2002.



nature of spruce stands in this area, this infestation will most likely remain confined to the river valley.

Copper River Valley

The Copper River Valley is the second major area of south central Alaska (behind the Kenai Peninsula) heavily impacted by the spruce beetle epidemic of the 1990s. This area has over 600,000 acres with near complete elimination of live forest cover.

Spruce beetle activity in the Copper River Valley is concentrated in two areas. The Hanagita River infestation has declined 20 percent over last year's figures, 4,039 acres in 2002 vs. 5, 058 acres in 2001. A portion of this infestation extends up the Klu River to tree line. It is expected that this activity will continue to decline due to the removal (by beetles) of the majority of susceptible host material. The remaining 3,200 acres of activity in the Copper River Valley is centered along the Kennicott River surrounding McCarthy, and in the adjacent McCarthy River drainage just east of McCarthy. The McCarthy River outbreak covers approximately 1,000 acres of moderately infested spruce, while 1,200 acres of moderate to heavy activity continues along the Kennicott River. The heaviest activity is located on the west side of the valley. Within this general area, there are extensive, contiguous stands of spruce along the Chitina, Tana, and Nizina Rivers that remain uninfested. This area will continue to be closely monitored.

Municipality Of Anchorage

Spruce beetle activity was mapped in the following areas within the Municipality of Anchorage in 2002 (beetle activity remains static with 2,978 acres mapped versus approximately 3,000 acres in 2001): Eklutna (741 acres), Eagle River (216 acres), Indian (860 acres) and Bird (700 acres) valleys. Scattered pockets of 10–30 trees were mapped in most areas. These small, discreet infestations have the potential to intensify, however, are unlikely to expand significantly due to a lack of large-diameter (susceptible) host material remaining from previous outbreaks. Potential for buildups of ample beetle populations exists if the patterns of mild winters and late spring warm periods continue.

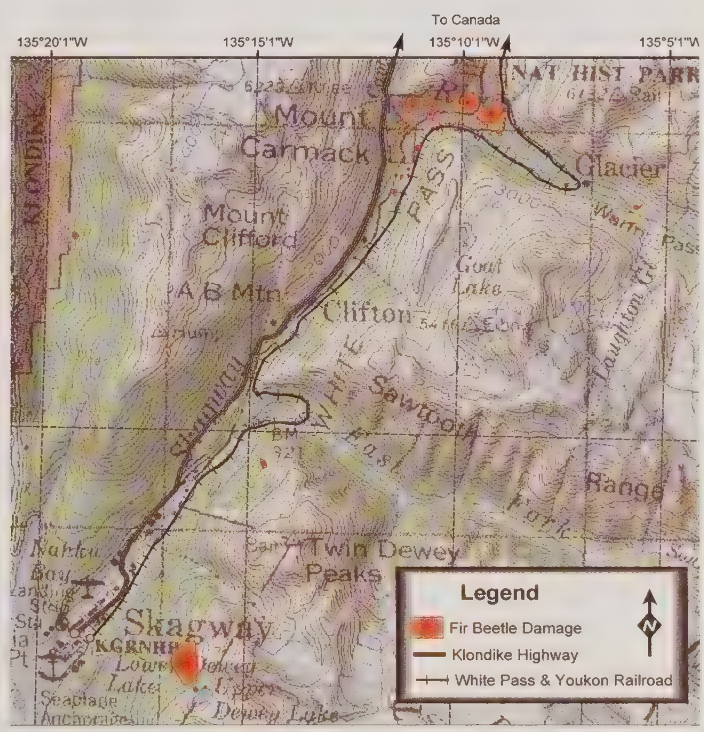
Southeast Alaska

In 2002, 335 acres of new spruce beetle activity was mapped in southeast Alaska compared to about 950 acres in 2001. Discrete, localized infestations were noted north of Haines in the upper Kelsall and Chilkat drainages (291 acres), Lituya Bay south of Yakutat (13 acres), and on Dall Island at Essowah Harbor (9 acres) and Hook Arm (22 acres).

Bark Beetles in Subalpine Fir

An unidentified bark beetle killed 56 acres of subalpine fir in the Skagway River drainage in 2001. The outbreak was assumed over, based on a limited field examination. However, this infestation increased almost four-fold in 2002, to 212 acres. The responsible beetle could be the western balsam bark beetle, *Dryocoetes confuses*; et al, however specimens still need to be collected and identified. Since the range of subalpine fir is very limited in Alaska, even a small outbreak is a significant impact to the resource.

Map 4. A small bark beetle outbreak in subalpine fir expanded in 2002.



Eastern Larch Beetle

Dendroctonus simplex LeC.

Aerial surveys in 2002 observed 4,800 acres of tamarack infested by the eastern larch beetle. Historically, large infestations of larch beetle have been recorded in the Alaskan interior. From 1974–1980 for example, over 8 million acres of tamarack scattered throughout the interior were infested. Though larch beetle activity has not been aerially detected during interior Alaskan surveys in nearly 10 years, there is little doubt that it has been active, at least at low levels, throughout the range of tamarack in Alaska. Ground surveys in the Innoko National Wildlife Refuge in 1999, conducted to assess impact to tamarack by the larch sawfly, found 1 percent of the trees infested with larch beetle. *Dendroctonus simplex* generally attacks injured and recently down trees, and those weakened by fire, flooding, and the larch sawfly. There was some expectation during the late 1990s that larch beetle populations would increase in response to 7 years of increasingly intense larch sawfly defoliation affecting 450,000 acres of tamarack throughout interior Alaska. This population increase never came about, or, if larch beetles were active in response to these stressed trees, aerial surveys were unable to detect or separate larch beetle activity from the overwhelming impact of the larch sawfly. The larch beetle activity observed in the 2002 aerial survey was located off the Kobuk River, near the Great Kobuk Sand Dunes, an area relatively unaffected by the larch sawfly outbreak of the 1990s. No obvious precipitating factors for this outbreak were observed.

Engravers

Ips perturbatus Eichh.

Engraver activity increased from only 30 acres reported statewide in 2001 to 1,253 acres in 2002. Though this increase in reported activity appears substantial, 1,253 acres is the second lowest figure reported in 20 years. The scattered *Ips*-caused tree mortality was noted primarily throughout interior Alaska, though a small area of *Ips* activity (32 acres) was observed on the Kenai Peninsula in south-central Alaska. *Ips* infestations occur mainly along river flood plains and areas disturbed by erosion, spruce top breakage (e.g., snow-loading), harvest, or wind. Most *Ips* activity is very localized and can be distinguished from spruce beetle damage by dying and reddening upper crowns in mature spruce. *Ips* are often associated with spruce beetle in the same general areas, however, *Ips* typically respond faster than spruce beetle in these areas since they are a more aggressive bark beetle in keying in to host stresses and nutrient changes brought on by these various disturbances. As is most often the case, the majority of *Ips* activity observed this year occurred along rivers. 150 acres of *Ips* infestations were mapped along the Tanana River between Big Delta and Birch Lake in 8 patches ranging from 1–25 acres in size; along the Yukon River, from Circle to Beaver, 530 acres of *Ips* activity was mapped and occurred in small pockets averaging approximately 30 acres in size; on the North Fork of the Kuskokwim River, approximately 15 miles northeast of Big River Roadhouse, 116 acres of activity was noted and was scattered over 3 different areas and, 213 acres near the confluence of the Nation and Yukon Rivers in the Yukon-Charley Rivers National Preserve.

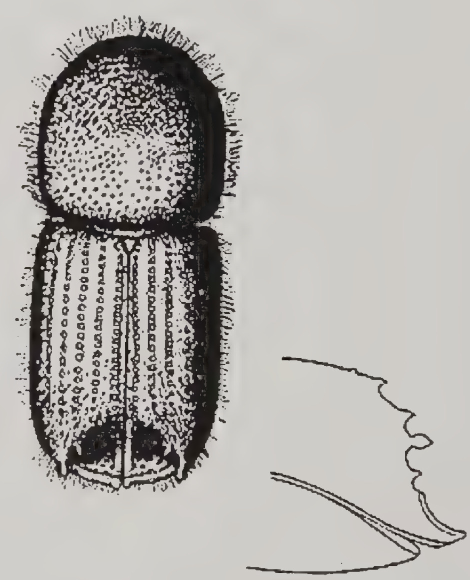


Figure 6. *Spines on the posterior distinguish **Ips** beetles.*

Defoliators

Defoliators as Agents of Disturbance

Defoliator insects eat the leaves or needles of forest trees. Insects that defoliate are found throughout Alaska and on all tree types. Bark beetles are often considered the more significant disturbance insects to trees in boreal Alaska (due to the high potential for causing tree mortality). Even so, defoliator insects can have a significant affect on both conifer and deciduous trees of this ecosystem, and can cause tree mortality with several seasons of defoliation. In maritime ecosystems, such as Prince Williams Sound and southeast Alaska, defoliator insects tend to be more significant agents of change. Conifer trees dominate these ecosystems. If complete defoliation of a conifer occurs before midsummer, the trees will not have formed buds for the following year and the tree could be killed.

In a defoliator outbreak where insect populations are at epidemic levels, vast acreages can be affected. During an outbreak nearly every tree in a stand can be affected to varying degrees. This defoliation often results in a variety of biological and ecological impacts, but there are socioeconomic impacts as well. Some of the impacts associated with a defoliator infestation include, but are not limited to:

- **Impacts to wildlife habitat**: Wildlife may be positively or negatively affected by defoliator outbreaks. Larvae are a necessary food source to fledge chicks but bird habitat may be negatively affected by the decrease in cover. Conversely, predatory birds may benefit from the cover change. The added light to the forest floor will result in an increased ground cover of herbaceous plants, benefiting browse animals such as deer.
- **Impacts to aquatic systems**: Aquatic systems may also be positively or negatively affected. Nutrient cycling is accelerated as foliage and insect waste enters the aquatic system. Larvae, themselves, drop into streams and can serve as a food source for fish. In addition, the loss of overstory cover can increase sunlight exposure to the stream, affecting the aquatic environment.
- **Economic concerns**: Heavy defoliation will decrease the growth rate of trees resulting delayed harvesting of merchantable trees. In addition to growth loss, repeated and or heavy defoliation events can cause top kill and in some cases tree death.
- **Aesthetics and Recreation**: The visual impact of a stand in the midst of an outbreak can be quite alarming when the entire hillside appears brown or red. However, the effect is often short term and once the dead needles drop to the ground, scenic quality returns closer to "normal." Large number of larvae can be a nuisance in picnic grounds and campgrounds. Defoliated stands also lose their attractiveness for recreation. Dead tops and dead trees pose a hazard in recreational areas.

Defoliator outbreaks tend to be cyclic and closely tied to climatic conditions. The synchronization of larval emergence and tree bud break is closely related to population increases. The better the synchronization of insect and host throughout larval development the more probable that an epidemic will occur. Higher temperature during pupation and egg laying improves adult emergence and survival, which increases the number of viable eggs that develop into larvae. When the number of viable eggs increases and the survival of larvae is greater because of warmer summer temperature the year following egg laying, an epidemic number of larvae can occur. Host-insect synchronization and favorable climate for insect development resulted in a tremendous acreage of defoliated western hemlock in the early 1950s. At the end of this epidemic, however, only ten percent of heavily defoliated trees were top killed and only a small number of those died.

Suppression efforts of insect populations are usually limited to small-scale urban settings or high value recreational sites. Suppression techniques vary depending on the species of defoliator. Healthy forests include periodic insect defoliation. Land managers should consider the predicted duration and

Figure 7 *Progression of top kill following repeated budworm defoliation.*

extent of the event and predicted resource effects when considering suppression actions.

Southeast Alaska Defoliator Plots

A part of the aerial detection survey for southeast Alaska includes monitoring plots for defoliating insects. These have been monitored annually since 1971 as larval counts from these plots can be used as a predictive tool for defoliator outbreaks. Three hundred and five trees and 31 plots, across southeast Alaska, were visited during the 2002 aerial survey. Sixteen plots had at least one defoliating insect. Ten plots had at least one hemlock sawfly and seven plots had six or more sawflies. The plot with the most hemlock sawflies is located on the West Arm of Cholmondeley Sound, Prince of Wales Island. Most of the hemlock sawflies occurred on trees south of Fredrick Sound. Black-headed budworms were found on only three of the 305 trees. Given the low sample numbers, we expect overall defoliator activity on hemlocks in southeast Alaska to be at endemic levels for 2003.

Figure 8. *Spruce aphid feeding on a spruce needle.*

Spruce Aphid

Elatobium abietinum Walker

Spruce aphids feed on older needles of Sitka spruce, often causing significant amounts of needle drop (defoliation). Defoliation by aphids cause reduced tree growth and can predispose the tree to other mortality agents, such as the spruce beetle. Severe cases of defoliation alone may result in tree mortality. Spruces in urban settings and along marine shorelines are most seriously impacted. Spruce aphids feed primarily in the lower, innermost portions of tree crowns, but may impact entire crowns during outbreaks. Outbreaks in southeast Alaska are usually preceded by mild winters.

An outbreak occurred in 1998 following a mild winter. In 2000, 39,400 acres of defoliation were detected, almost as many acres as in 1998. Seventy-five percent of these acres (29,500 acres) were on national forest lands. The defoliation in 2000 was primarily on south to west facing slopes.

In 2001, 20,200 acres of beach fringe trees were infested along the mainland from the Stikine River to Yakutat Bay. Admiralty, Douglas, Hecata, and Wrangell Islands were also infested. The most notable urban area outbreaks were in Juneau and Wrangell.

In 2002, there was a period of very cold weather during the first week of April that killed many of the overwintering aphids. Several dead and shrunken aphid cadavers were found on branches. Most of the 2,336 acres of this year's defoliation occurred on national forest lands (1,640 acres). The greatest concentrations of infested acres were on the outer islands near Craig (791 acres) and on the northeast facing shore of Lynn Canal (478 acres).

Western Black-headed Budworm

Acleris gloverana Walsingham

The western black-headed budworm is native to the forests of coastal and southwestern Alaska. It occurs primarily in southeast Alaska and has been documented there since the early 1900s. More recently, black-headed budworm populations followed a general increasing trend during the early 1990s but have been declining since that time. In southeast Alaska, a peak year for budworm defoliation occurred in 1993, impacting approximately 258,000 acres. The last black-headed budworm outbreak of this magnitude occurred over a ten-year span between the late 1940s and mid-1950. Cool, wet weather in May and June retards the growth and development of the caterpillars and may have resulted in population declines. From 1998 through 2000, no black-headed budworm defoliation was detected during

Figure 9. *Black-headed budworms are distinguished by a dark shield behind the head capsule.*

the annual aerial surveys throughout the coastal areas, including the southeast Alaska panhandle. Last year, approximately 50,724 acres of visible defoliation was observed in two areas, the Wood River-Tikchik lake country north of Dillingham and eastern Prince William Sound. In 2002, black-headed budworm activity was mapped on 3,354 acres.

In southeast Alaska this year, 350 acres of budworm activity was observed at LeConte Bay, east of Petersburg, primarily on western hemlock. A number of ground plot samples collected during the southeast Alaska aerial survey yielded no budworm larvae in most samples. In Prince William Sound, approximately 3,010 acres of moderately to severely defoliated hemlock were mapped from Whittier easterly to Cordova in the following areas: Passage Canal, 640 acres; Culross Island, 41 acres; Unakwik Bay, 1,756 acres; Long Bay, 128 acres; Valdez Arm, 13 acres; Bligh Island, 228 acres; Simpson Bay, 96 acres; Port Fidalgo, 20 acres; Port Gravina, 12 acres; Hawkins Island, 6 acres; Orca Inlet, 37 acres; Hinchinbrook Island, 32 acres.

Within the Wood River-Tickchik Lakes State Park, north of Dillingham, 30,000 acres of moderate to heavy black-headed budworm activity was mapped in 2001. Aerial surveys in 2002 identified 5,182 acres of active spruce budworm infestations located in the Wood–Tikchik area, a reduction of more than 80 percent over 2001 levels. This year's activity was concentrated along the lower lakes of the Park, namely, Lake Nerka, Lake Aleknagik and Nunavaugaluk Lake and is classified as moderate to heavy in intensity. The future course of this current infestation remains unclear. The Wood River–Tickchik Lakes area is surveyed annually and this infestation will be re-evaluated in 2003. The last time black-headed budworm defoliation was detected in this area was in 1979, when nearly 3,000 acres of white spruce defoliation were noted in the Grant Lake–Lake Kulik area. No further evidence of this outbreak was noted the following year.

Budworm populations in Alaska have been cyclic, appearing quickly, affecting extensive areas, and then decreasing just as dramatically in a few years. Consecutive years of budworm defoliation may cause growth loss, top-kill, and in severe outbreaks, substantial lateral branch dieback can lead to the death of large numbers of trees. Generally though, heavily defoliated trees may be weakened and predisposed to secondary mortality agents. As a major forest defoliator, black-headed budworm can significantly influence both stand composition and structure to favor small mammals, deer, predaceous and predatory insects, and some insectivorous birds as a direct result of increases in shade tolerant understory plants (i.e., through tree death or crown thinning).

Yellow-headed Spruce Sawfly

Pikonema alaskensis Rohwer

Due to a dry, warm spring and early summer in the Anchorage Bowl, yellow-headed spruce sawfly populations rapidly built up on ornamental spruce. Defoliation was heavy and almost complete on many spruces that were planted in stressed micro-sites. A very intensive but localized infestation was observed within a six-block area along Tudor Road in east Anchorage during July. This defoliator is not considered a serious forest pest, but can affect the aesthetic value of urban trees, and can kill the tree in

Figure 10. *Larvae of the yellow-headed spruce sawfly.*

cases of heavy defoliation. The full-grown larvae are shiny and about 20 mm long. Their head is chestnut brown to reddish yellow with the body an olive-green above and lighter green below. Sawfly adults are straw yellow to nearly black wasps about 10mm long. There is one generation per year. Eggs are laid in the current year's needles and occasionally in the tender bark of expanding shoots. The larvae first feed on the new needles and then on the old. In late summer, larvae drop to the ground and spin symmetrical oval cocoons in the duff or topsoil. Larvae overwinter as prepupae.

Hemlock Sawfly

Neodiprion tsugae Middleton

Hemlock sawfly, a common defoliator of western hemlock, is found throughout southeast Alaska. Historically, sawfly outbreaks in southeast Alaska have been larger and of longer duration in areas south of Frederick Sound.

In 2002, only 1,355 acres were detected, almost all of it south of Sumner Strait, south of Frederick Sound. Most of the acreage occurred on the southwest end of Kosiusko Island and on the northwest facing shore of Boca De Quadra Inlet, Misty Fiords National Monument.

Unlike the larvae of the black-headed budworm, hemlock sawfly larvae feed in groups, primarily on older hemlock foliage. These two defoliators, feeding in combination, have the potential to completely defoliate western hemlock. Heavy defoliation of hemlock by sawflies is known to cause reduced radial growth and top-kill. Hemlock sawflies may ultimately influence both stand composition and structure. The sawflies themselves are a food source for numerous birds, other insects, and small mammals.

Larch Sawfly

Pristiphora erichsonii Hartig

In 2002, larch sawfly activity continued a decline that began after 1999 when sawfly populations impacted nearly 450,000 acres. This year, no larch sawfly defoliation was recorded during aerial surveys. The steady decline of this infestation is due to massive mortality incurred by native larch in interior Alaska. Throughout the course of this infestation, first observed during aerial surveys in the summer of 1993, over 200,000 acres of larch have been affected by substantial mortality. Nine years of increasingly heavy defoliation has taken its toll on these vast stands of larch. A biological evaluation conducted in August 2000 within the Innoko National Wildlife Refuge by Forest Health Protection staff found that within the areas studied, 70 percent of the live larches were severely defoliated, while 27 percent of the total component of larch had died. Reports from the Innoko Wildlife Refuge staff indicated that, as of 2002, approximately 70 percent of the larches were dead, 29 percent were barely alive, and 1 percent appeared unaffected by repeated sawfly defoliation. In south-central Alaska, the larch sawfly has

Figure 11. *Larch sawfly larvae have caused massive defoliation and mortality in recent years.*

continued its advance southward affecting ornamental Siberian Larch plantings from Sterling to Homer on the Kenai Peninsula. In what appeared to be an accidental introduction, first noted in the MatSu Valley and within the Municipality of Anchorage (Anchorage Bowl, Eagle River) during 1999 surveys by Cooperative Extension technicians, this pest of native larch in interior Alaska, has apparently established a solid foothold south of the Alaska Range into south-central Alaska's urban and community forest areas. While larch is not native south of the Alaska Range, it is a popular landscape tree. The ornamental (Siberian) larch plantings appear to be less susceptible to stress from repeated defoliation by the sawfly and are responding better to nonchemical control measures. Expansion of the larch sawfly into the south-central Alaska urban areas has been swift and it appears that eradication is not feasible or practical.

Figure 12. *Typical blotch miner damage on a hardwood leaf.*

Aspen Leaf Blotch Miner

Phyllocnistis populiella Chambers

Populations of the aspen leaf blotch miner have risen dramatically in the past year, from 2,300 acres of reported activity in 2001, to 299,468 acres in 2002. The vast majority of this activity, 91 percent, or 271,000 acres, is located between the Yukon and Porcupine Rivers, approximately 65 miles southeast of Ft. Yukon. Two other ongoing infestations of note by this leaf miner are: nearly 20,000 acres in the immediate vicinity of Delta Junction, and 6,500 acres scattered between Murphy Dome, 15 miles northwest of Fairbanks, and the Minto Lakes region. Nearly all active infestations of this leaf miner observed this year would be classified as moderate to severe in intensity. Winter is spent as adults under bark scales of conifers and hardwood trees. Adults emerge in early June and deposit eggs singly on the leaf edge. The newly hatched larvae bore and feed between epidermal leaf tissues. Pupation occurs within the leaf mines. Heavy repeated attacks reduce tree growth and may cause branch dieback, or in some cases, tree death. These new infestations will be closely monitored during aerial surveys over the next few years to assess their impact on these extensive stands of aspen.

Large Aspen Tortrix

Choristoneura conflictana Wlkr.

Activity attributed to large aspen tortrix in 2002 fell 65 percent over 2001 levels to 2,480 acres. All observed activity occurred in just one area, that being Bearpaw Mountain on the Kantishna River approximately 60 miles south of Manley Hot Springs. The decline in acres infested in 2002 follows an increase in 2001 of 22 percent over 2000 levels. Significant as these figures may sound, population increases and decreases of this magnitude are consistent with the cyclic nature of this insect. Tortrix activity lasting for a year or two in smaller, discreet patches of aspen along the Kantishna River has been observed for a number of cycles. The large aspen tortrix is host to numerous insect parasites and is further controlled by adverse weather. Starvation of larvae, however, is considered the likely demise of many outbreaks. This outbreak is expected to follow the pattern most common to this insect and will not likely last more than another year.

Birch Leaf Roller

Epinotia solandriana L.

The most common leaf roller on birch, *Epinotia solandriana* L., is a recurrent problem in south-central and interior Alaska, infesting both urban and forest-growing birch. In the late 1970s, a large outbreak of this insect, lasting several years, impacted

birch throughout the Anchorage bowl. Since that time, occasional, small outbreaks attributed to this insect have been reported, particularly in birch stands on the Kenai Peninsula. Severe and repeated defoliation by this leaf roller is required to kill birch. Generally, at most, defoliation results in minor growth reduction and occasional branch dieback. Adverse weather, parasites, predators, and disease reduce large populations of leaf rollers. This year's aerial survey reported nearly 53,000 acres of leaf roller activity. North of Dillingham, 31,000 acres of this total were observed in the Wood River–Tikchik Lakes State Park. The impact to these birches is considered severe, with nearly all of the trees in the affected area 90–100 percent defoliated. Ground checks of the area confirmed the causal agent to be the birch leaf roller. Further, 15,000 acres of leaf roller activity were noted just east of Mount Susitna, 40 miles northwest of Anchorage. This infestation would be characterized as moderate in intensity.

Figure 13. *The cottonwood leaf becomes skeletonized as the mass of leaf beetle larvae pass by.*

Cottonwood Defoliation

***Chrysomela* spp.**
***Epinotia solandriana* L.**

The black-colored leaf beetle larvae skeletonized the leaves of black cottonwood or poplar giving the trees a brown appearance. Though cottonwood leaf beetle defoliation was scattered throughout the state, a large amount of it (788 of 1922 acres) was detected along the Chilkat, Tsirku, and Takhin River drainages, northwest of Haines.

In 2002, in southeast Alaska, there were 14,136 acres of leaf roller (*Epinotia solandriana*) defoliation detected. About 5,287 acres of those acres were near Yakutat and mostly on the west bank of Russell Fiord. Several large areas of heavy defoliation were detected (8,849 acres) on the shores of Berg Bay, Glacier Bay National Park. *E. solandriana* also infests alder in areas mapped as cottonwood leaf roller.

Willow Leaf Blotch Miner

***Micrurapteryx salicifolliela* (Chambers)**

The willow leaf blotch miner has been active, primarily in the Yukon Flats National Wildlife Refuge area, for 11 consecutive years. This population has been in decline for the past several years, and with only 62 acres of aerially observed blotch miner activity in 2002, the outbreak appears to be over. Aerial detection surveys conducted in this vast area are restricted to the major river drainages by cost and time constraints. Consequently, much of this area is necessarily overlooked, and pockets of blotch miner might remain active in areas not surveyed. It is doubtful, however, that unsurveyed areas containing potential blotch miner activity would add significantly to the total reported acres of activity. Considerable willow mortality was observed in areas where the blotch miner has historically been active, most notably on the margins of muskegs and river sloughs. There are concerns of willow mortality effects on moose carrying capacity, however, to date, no effort has been made to quantify the amount of mortality observed or these effects.

Alder Defoliation

Epinotia spp.

The late spring and early summer of 2002 were unseasonably dry throughout much of south-central Alaska. As a consequence, early in the growing season, conditions were favorable for insect population build-up as well as water stress to trees. This impacted hardwood trees (i.e., birch affected by leaf miners and alder by alder woolly sawfly—refer also to Invasive Pests section) and important shrub species in some areas, most notably Sitka alder (*Alnus sinuata* (Reg.) Rydb.) and red alder (*A. rubra* Bong.) on sun-exposed slopes. Later in the summer, precipitation returned to normal but populations had already grown to epidemic levels. Feeding damage from this characteristic defoliation pattern is "skeletonizing" whereby the chlorophyll-containing portions of the leaf are eaten away causing the leaves to curl, brown, and drops prematurely. At worst, defoliation of alder usually results in minor growth reduction and occasional branch dieback. Alder is a major nitrogen fixer and nurse species for other plants (e.g., spruce) over the successional continuum; it is also an early successional species important for soil stabilization on eroded slopes and other disturbed sites throughout Alaska.

Figure 14. *Notice how feeding from the alder wooly sawfly almost entirely consumes the leaf on the right.*

Invasive Pests

Invasive plants, insects and diseases have been seen increased publicity both nationally and within Alaska. Sudden Oak Death (disease) in California, Gypsy moths (insects) in the Appalachians, and spotted knapweed (plants) in the interior west are all rapidly becoming well known across the country. Invasive pests (introduced nonindigenous plants, animals, insects, and microbes) are among the most serious threats to biological diversity in Alaska; although, to date, few invasive pests have been introduced and established in Alaska. Of concern are the movement of organisms from the continental U.S., Canada, and the Russian Far East into Alaska in light of climate change and increased commerce. Likewise, the movement of native insects and pathogens from one area to another, apparently geographically isolated, is also problematic. A warming trend may increase the probability that organisms accidentally introduced into Alaska will become established. Once established, invasive pest populations can become difficult to control and manage since the complement of parasites and predators that normally control their numbers are at low levels, or absent.

It is inevitable that we are going to see more and more introduced pests "invading" both rural and urban forest areas of Alaska. If pest introductions are left to "run their course" or if we are not prepared to expend the efforts to safeguard our ecosystems, Alaska will be poorer in terms of resources and biological diversity. For example, without eradication efforts, many invasive insects could inadvertently become a dominant influence affecting native species of both pest and nonpest insect populations. The ability of many introduced pests to out-compete or displace the native species will complicate Integrated Pest Management (IPM) efforts already in place. USDA Animal & Plant Health Inspection Service (APHIS), the State of Alaska divisions of Agriculture and Forestry (AKDOF), University of Alaska Cooperative Extension Service (CES), and the USDA Forest Service, Forest Health Protection already have small programs in place to monitor and detect potential insect or plant introductions. Alaska residents, resource professionals, and land managers need to "keep a sharp eye" out for potential introduced pests and contact CES, APHIS, or AKDOF. If introduced pests are positively and quickly identified, the probability of successful eradication or IPM control efforts are increased.

Invasive Insects, diseases and animals

The following include some of the primary invasive insects, diseases and animals detected in Alaska to date. Northern Pike have been introduced from north of the Alaska Range (where they are native) to areas south of the Alaska Range. ADF&G has become quite concerned since pike can have a large impact on Salmonid populations (See the ADF&G website for further information). Additionally, a snapping turtle was found in a Homer area pond, and had apparently survived there for several years.

Amber-marked Birch Leaf Miner

Profenusa thomsoni (Konow)

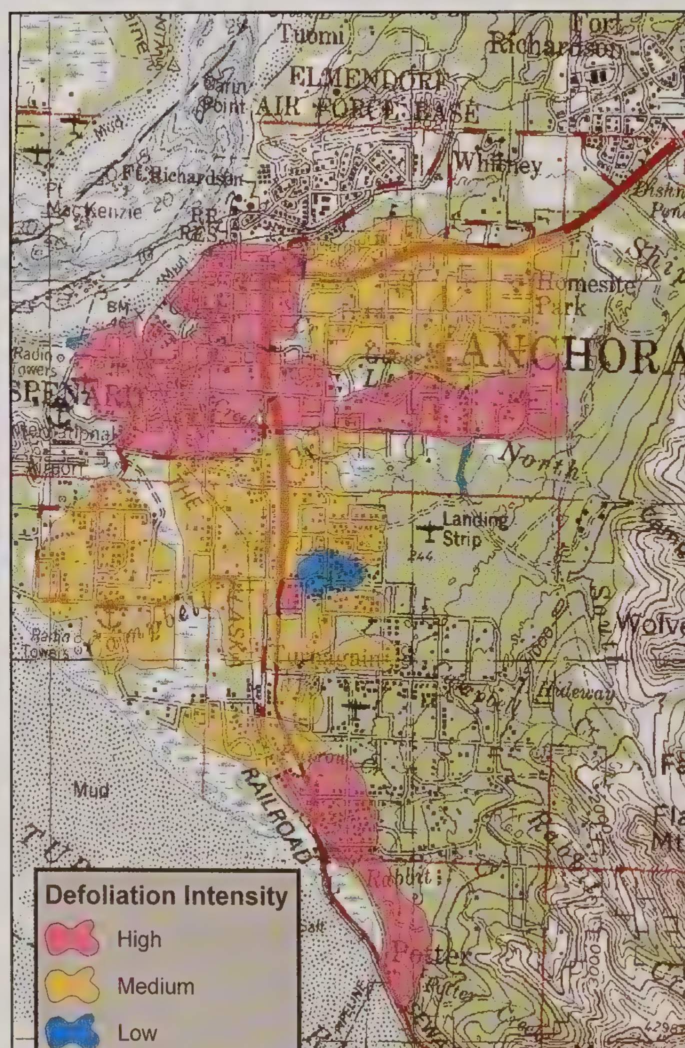
Birch defoliation was very noticeable in the Anchorage Bowl from late July to August. More than 25,000 acres of defoliated birch were mapped during aerial surveys. Although these hardwoods have been defoliated for several consecutive years, as yet there doesn't appear to be any lasting damage.

A significant causal agent was identified as the Amber-marked birch leaf miner (*Profenusa thomsoni*). It appears that this leaf miner is a recent introduction into the Anchorage Bowl and is rapidly expanding. Up to this year, leaf miner defoliation was only concentrated in the Anchorage Bowl area. The leaf miner has since spread into the Eagle River area and as far south as Bird Ridge; approximately 30 miles south of Anchorage. It was also accidentally introduced into the Fairbanks area. More than 1,000 heavily defoliated birch were observed on Eielson AFB.

This birch leaf miner was first reported in eastern United States in the early 1900s. Introduced from Europe, it has spread rapidly throughout the northern United States, Canada, and recently into Alaska. The adult sawfly is black, about 3 mm long, and similar in appearance to a common fly. Adult sawfly populations are comprised of females, reproduction is parthenogenic. Larvae overwinter in cocoons in the soil and adults appear in the summer months from early July through August. The female sawfly deposits her eggs singly on mature leaves. At times, almost every leaf is mined by as many as ten developing larvae, giving it a brown color. When mature, the larva cuts a hole through the leaf and drops to the ground. There the larvae build a cell in which they over-winter. One generation per year is normal for this leaf miner.

The Amber-marked leaf miner was first reported in Edmonton, Alberta, Canada in the early 1970s. This leaf miner grew to become the most important exotic leaf miner on Edmonton's birch trees. In the early 1990s a highly specific biological control agent, a holarctic ichneumonid parasitic wasp, *Lathrolestes luteolator* (Gravenhorst) (Hymenoptera: Ichneumonidae), appeared in Edmonton. Not only did this wasp cause the twenty year long outbreak to collapse, it has made this exotic leaf miner rare, curing the need for one of the most entrenched

Map 5. Birch defoliation mapped in the Anchorage Bowl at varying intensities.



and widely practiced insecticide treatments in Edmonton.

We do not believe we have *L. luteolator* in Alaska as this species was trapped for this summer and no specimens were collected. This parasitic wasp would be a promising biological control agent for the birch leaf miner. In the absence of an efficient biological control agent, birch leaf miner populations will continue to spread unchecked throughout many parts of south-central and interior Alaska's birch forests.

Alder Woolly Sawfly

Eriocampa ovata (L.)

Heavy defoliation of thin-leaf alder (*Alnus incana*) was observed for the sixth consecutive year in many parts of the Anchorage Bowl; especially in riparian areas. Sitka alder (*A. crispa*) was seldom defoliated. Similar to the birch leaf miner, the alder woolly sawfly appears to be a recent (less than seven years) introduction into the state. This sawfly is a European species now established throughout the northern U.S., Canada, and recently into Alaska. The larvae are covered with a distinctive shiny, woolly secretion. They skeletonized the lower leaves on young alders; the upper crown is usually not fed upon.

Gypsy Moth

Lymantria dispar (L.)

The European gypsy moth was accidentally introduced into the eastern U.S. in the late 1800s and has been responsible for considerable damage to the hardwood forests of the east. The gypsy moth has also been introduced to the western U.S. where millions of dollars have been spent on its eradication.

Since 1986, Forest Health Protection, in conjunction with Alaska Cooperative Extension and USDA APHIS, has placed gypsy moth pheromone monitoring traps throughout Alaska. To date, only two European gypsy moths have been trapped in Alaska. As far as we know, populations of the gypsy moth have not been established in Alaska.

Due to the detection of the Asian gypsy moth (a more damaging race of the European gypsy moth) in the Pacific Northwest, more than 200 detection traps were placed throughout Alaska in

Figure 15. *Adult male gypsy moth.*

2001. Similar trapping densities were continued in 2002 by the University of Alaska, Fairbanks and Forest Health Protection cooperators. No Asian or European gypsy moths were collected. If the Asian gypsy moth becomes established in the western U.S., including Alaska, the potential impacts to forest and riparian areas could be tremendous. The trapping program will be funded on a continuing basis.

Uglynest Caterpillar

Archips cerasivorana (Fitch)

In 2001, Cooperative Extension Service and Alaska Division of Forestry entomologists found the Uglynest caterpillar on Cotoneaster and mountain ash hedge plantings in west Anchorage, downtown and in south Anchorage. Moderate to heavy defoliation occurred in the same areas in 2002, significantly expanding along mountain ash row plantings in the downtown area. In 2002, Uglynest caterpillar feeding was also observed on apple and crabapple (*Malus* spp.); moderate to severe branch dieback was also noted on mountain ash in the downtown area. The insect has one generation per year, over-wintering in the egg stage. The adult moths are active from June through August; the front wing is crossed with reddish brown striations and has an iridescent sheen; hind wings are bright orange. Larvae are yellowish to yellowish-green as they reach maturity with dark brown or black heads. All larval stages are gregarious and live in silk-covered tents or nests that become filled with frass as the larvae grow. This insect can be a problem in nurseries or ornamental

Figure 16. *Larval stages of the uglynest caterpillar are gregarious feeders and live in silk-covered tents.*

plantings because of the unsightly appearance of the larval nests. The larval nests may also cause some branch deformity.

European Black Slug: Limacidae

Arion ater

The European black slug, an invertebrate, was detected twice in a local Anchorage garden in 2000, and again in 2001. Reports of damage to garden crops continued in 2002 in Anchorage. This introduced slug was likely imported on flats of bedding plants that originated from Washington State. A distinctive feature of this slug is the many grooves and ridges along the back. This reddish-brown slug has a distinctive striped red-orange skirt. When fully extended, this slug measures almost 6 inches in length. The European black slug is established in the northwest U.S. and is a serious pest of crops including corn, wheat, potatoes, beans and strawberries.

Leopard Slug: Limacidae

Limax maximus

A slug (about 5 inches long and one-half inch diameter, tan-beige colored and with elongated black splotches all over its back except its mantle) was tentatively identified as a leopard slug last year. Local gardeners indicate that these slugs have been found about 15 miles north of Juneau for several years now. Populations were observed in several southeast Alaska communities during 2002.

Black knot

Apiosporina morbosum

Black knot was first discovered in Anchorage in the early to mid 1980s. The fungus quickly spread, and by 1987 the municipality of Anchorage had pruned black knot from over 135 trees throughout the city. The disease is now established in the Anchorage bowl. *Prunus padus* and *P. virginiana* are the most commonly affected ornamental trees in south-central Alaska, while the Amur chokecherry, *P. maackii*, does not appear to be susceptible to the disease. Reports of damage to ornamental trees continued in 2002 in Anchorage.

Infected trees develop perennial black corky swellings or "knots" on branches or the tree bole. Tree mortality has not been attributed to this fungus, although branch dieback has been observed. The primary impact from this disease is loss of aesthetic and economic value of ornamental Prunus plantings. Black knot has costly impacts on landscape contractors, nurserymen, businesses, local government, and homeowners, due to the dismissal of infected stock and/or the removal & replacement of infected trees.

Figure 17. *The pneumostome (air hole) can be seen in this leopard slug.*

Figure 18. *The fungus* ***Apiosporina morbosum*** *causes black knot.*

Fire blight

Erwinia amylovora

Fire blight, caused by a bacterium, was detected in Anchorage in 2002 on ornamental apple trees and rose bushes. The disease was likely introduced from imported plant material. Annual reports of fire blight seem to sporadically occur on ornamental trees across the Anchorage Bowl. It is not known whether this disease is established. The bacterium causes leaves and blossoms near the tips to turn brown and die. Infections can move to older portions of the plant, causing cankers and branch dieback. Cankers may weep a cloudy, bacteria-laden sap. A concern is the possibility of an outbreak of fire blight on mountain ash, *Sorbus* sp., trees.

Invasive Plant Species

While invasive insect and disease pests are very obvious and direct in their effects on the habitat (and humans), most of the plant invasives are initially less obvious or pervasive in their expansion into new habitats. Presently, most of the invasive plants are found in disturbed areas, primarily in the developed urban parks and on agricultural lands. Left unchecked, these invaders may overrun other disturbed areas, including forest harvest areas, field tree nurseries, etc., displacing native ground plant cover. A number of weedy (plant) exotics are spreading through the urban forest and agricultural areas of Alaska.

In 2002 the Weed Scout program, with Cooperative Extension Services, collected over 1,000 data points; Map 6 is an example of some of the points collected for white sweet clover and bird vetch. Another species that is spreading in the Anchorage area, especially in south Anchorage, is Perennial sow thistle.

Japanese knotweed (*Polygonum cuspidatum*) is extremely widespread in most communities. Contaminated soil that is being moved around for construction and landscape reasons is the primary culprit for the spread. In Juneau the number of verified garlic mustard plants has increased exponentially in just one year. Local volunteers, city, state and federal agencies mounted aggressive eradication efforts in 2002 to try to head off the further spread of garlic mustard. Another species recently introduced in Wrangell as an ornamental is Himalayan balsam (*Impatiens glandulierera*) which is a serious invasive in Europe.

The table on the following page lists a few of the more important invasive species.

Map 6. Invasive plant survey in Anchorage

Table 3. Invasive plants that were identified at the 2nd annual Invasive plant meeting as potentially the most problematic species for Alaska.

Genus	Species	Common Name	Family	Present in Alaska
Acroptilon	*repens*	Russian Knapweed	Asteraceae	N
Alliaria	*petiolata*	Garlic Mustard	Brassicaceae	Y
Alopecurus	*pratensis*	Candle grass	Poaceae	Y
Capsella	*bursa-pastoris*	Shepherds Purse	Brassicaceae	Y
Centaurea	*biebersteinii*	Spotted Knapweed	Asteraceae	Y
Chenopodium	*album*	Lambs quarters	Chenopodaceae	Y
Chosenia	*arbutifolia*	Korean Willow		N
Cirsium	*arvense*	Canada Thistle	Asteraceae	Y
Cotula	*coronopifolia*	Brass Buttons	Asteraceae	Y
Crepis	*tectorum*	Narrow-Leaf Hawksbeard	Asteraceae	Y
Cytisis	*scoparius*	Scotch Broom		Y
Elymus	*repens*	Quack grass	Poaceae	Y
Euphorbia	*esula*	Leafy Spurge	Euphorbiaceae	N
Galeopsis	*tetrahit*	Hemp nettle	Lamiaceae	Y
Heracleum	*mantegazzianum*	Giant Hogwort	Apiaceae	N
Hieracium	*umbellatum*	Narrow-Leaf Hawkweed	Asteraceae	Y
Leucanthemum	*vulgare*	Oxe-Eye Daisy	Asteraceae	Y
Lythrum	*salicaria*	Purple Loosestrife		N
Matricaria	*discoidea*	Pineapple Weed	Asteraceae	Y
Melilotus	*alba*	Sweet Clover (White)	Fabaceae	Y
Myriophyllum	*spicatum*	Eurasian Water milfoil	Haloragaceae	Y
Neslia	*paniculata*	Ball Mustard	Brassicaceae	Y
Onopordum	*acanthium*	Scotch Thistle	Asteraceae	N
Phalaris	*arundinacea*	Reed Canary Grass	Poaceae	Y
Polygonum	*convolvus*	Black Bindweed	Polygonaceae	Y
Polygonum	*cuspidatum*	Japanese Knotweed	Polygonaceae	Y
Rumex	*acetosella*	Sheep Sorrel	Polygonaceae	Y
Senecio	*vulgaris*	Tansy Ragwort	Asteraceae	Y
Sonchus	*arvensis*	Perennial Sow thistle	Asteraceae	Y
Spergula	*arvensis*	Corn Spurry	Caryophyllaceae	Y
Taraxacum	*officinale officinale*	Common Dandelion	Asteraceae	Y
Vicia	*cracca*	Tufted (Bird) Vetch	Fabaceae	Y

Nomenclature follows Kartesz and Meacham, Synthesis of the North American Flora, 1999.

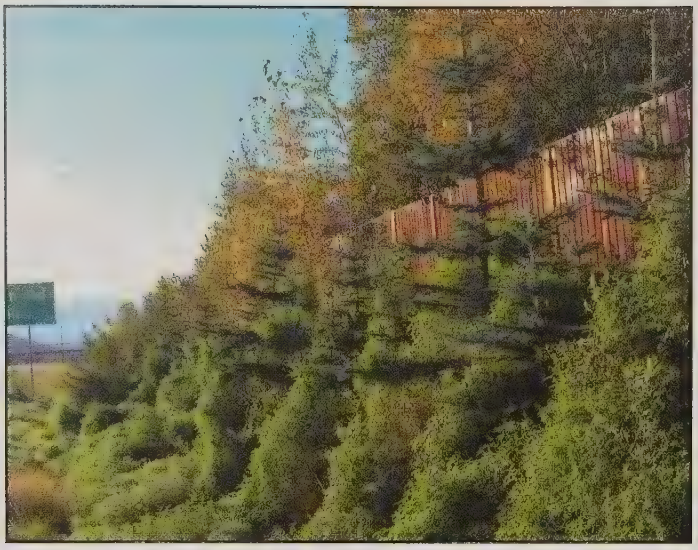


Figure 19. *Bird Vetch along the Seward Highway seen here dominating the spruce.*

Figure 20. *Japanese Knotweed is common in several towns of southeast Alaska.*

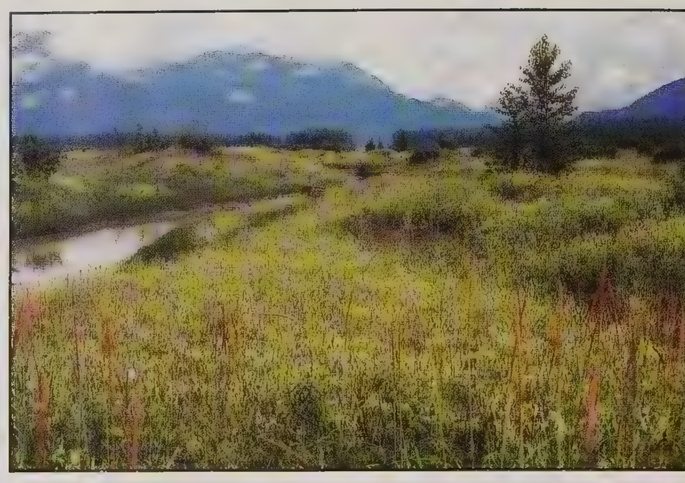
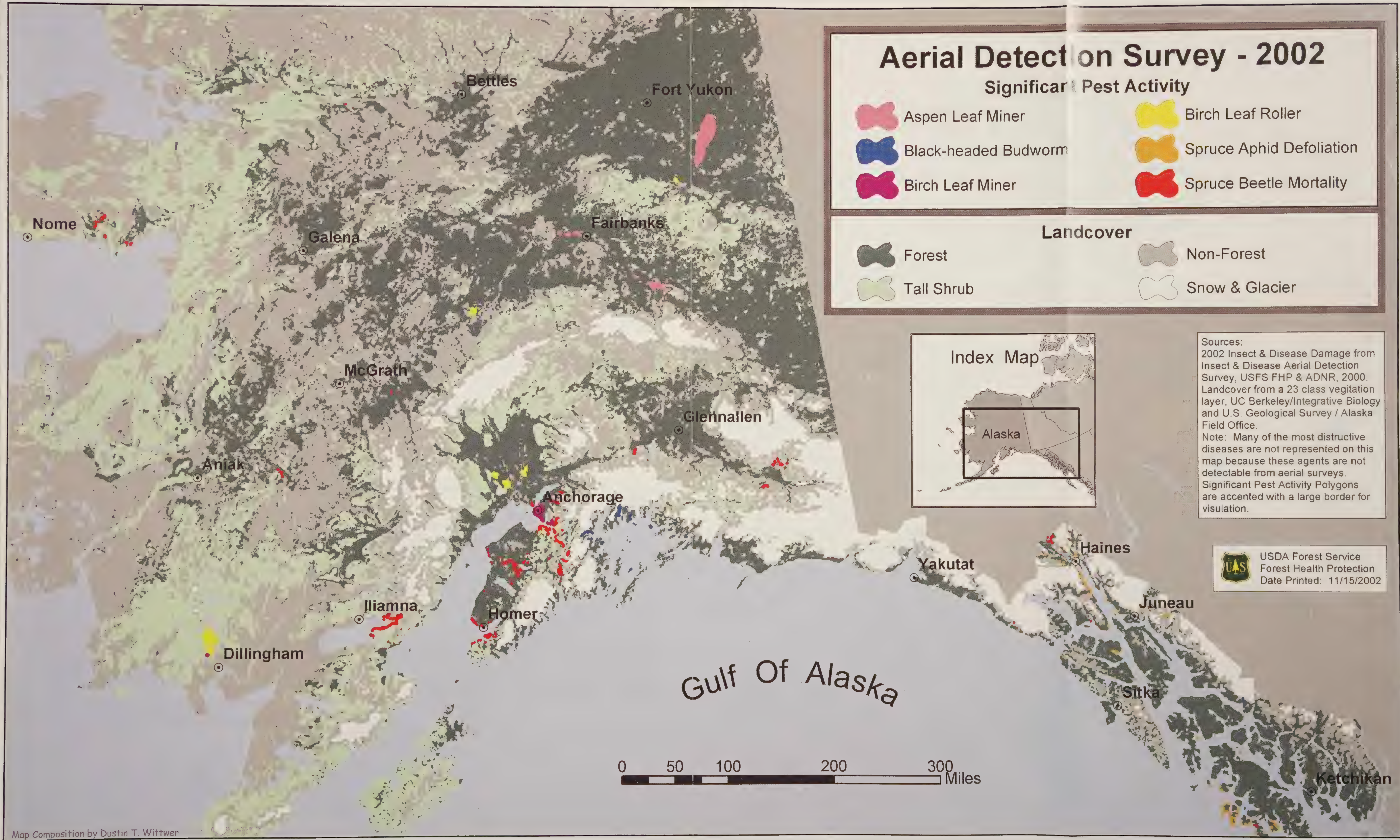


Figure 21. *White Sweet clover has taken over this Stikine River location.*

Figure 22. *Garlic Mustard was pulled from sites in Juneau, including an area adjacent to the Governor's mansion.*

Map 7. General Forest Pest Activity in 2002.



Map 8. 2002 Survey Flight Paths.

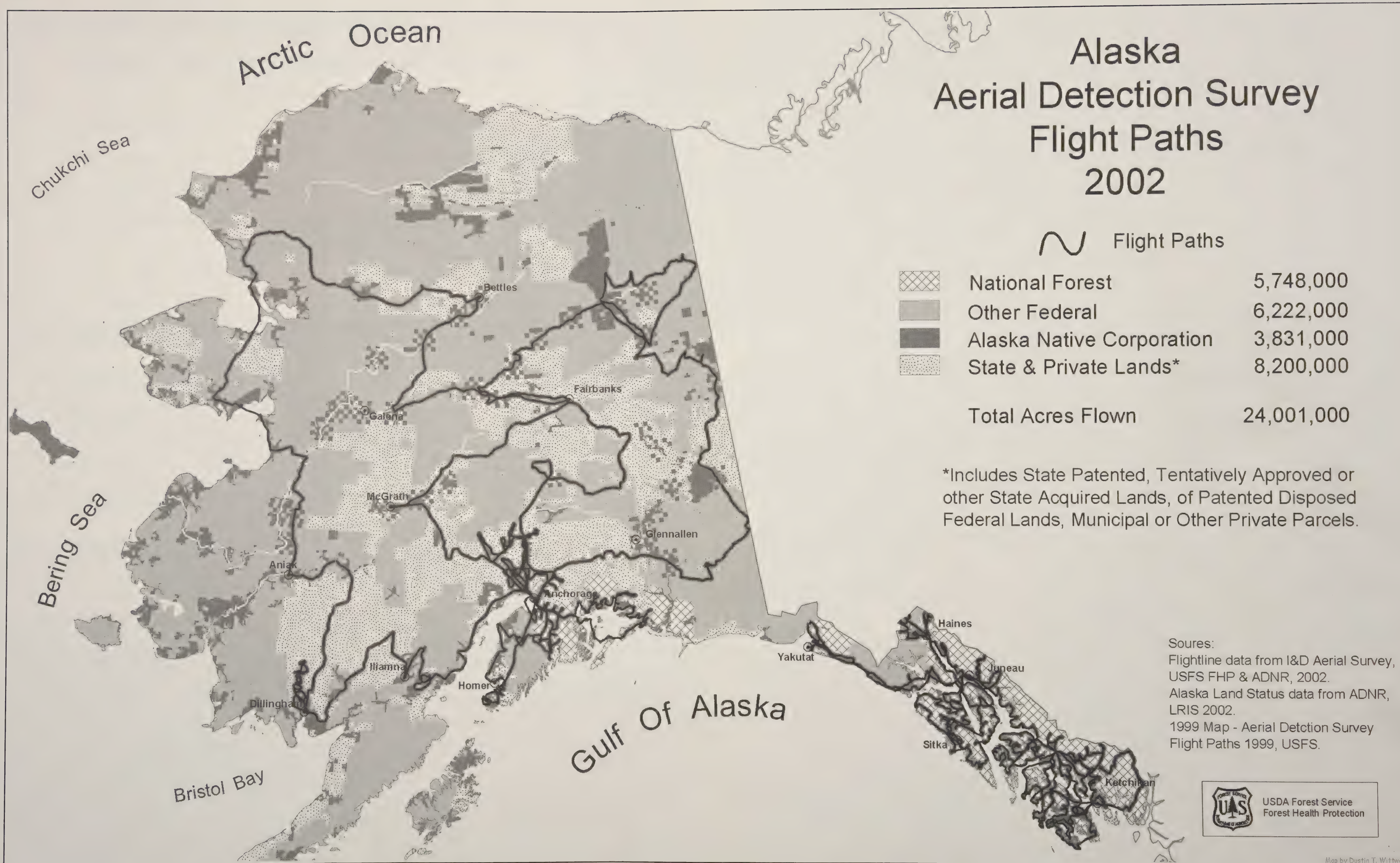


Figure 23. *Birch leaf miner, an invasive insect, was very visible in the Anchorage Bowl in 2002.*

Figure 25. *Yelloheaded spruce sawfly caused notable damage on some ornamental spruce around Anchorage in 2002.*

Figure 26. *Resinous punk knots or blink conks on spruce are signs of the red ring rot,* ***Phellinus pini****, and a heart rot pathogen.*

Figure 24. *A warm spell followed by as cold snap in the spring of 2002 affected many southeast Alaska trees coming out of dormancy.*

Ecological Roles of Forest Diseases

The economic impacts of forest diseases in Alaska have long been recognized. In southeast Alaska, heart rot fungi cause substantial cull of nearly one-third of the gross volume in old-growth hemlock-spruce forests. In the south-central and interior regions, substantial cull from decay fungi also occurs in white spruce, paper birch, and aspen forests. Traditionally, management goals sought to eliminate or reduce disease to minimal levels in an effort to maximize timber outputs. As forest management goals broaden to include enhancement of multiple resources and retaining structural and biological diversity, forest disease management can be assessed from an ecological perspective.

Diseases can play key ecological roles in the development and sustainability of Alaskan forest ecosystems. They enhance biological diversity, provide wildlife habitat, and alter forest structure, composition, and succession. As agents of disturbance in the western hemlock-Sitka spruce forests of southeast Alaska, diseases apparently contribute to the "breaking up" of even-aged stands as they are in transition (i.e., 150 to 200 years old) to old-growth phase. Diseases appear to be among the primary factors that maintain stability in the old-growth phase through small-scale (canopy-gap) level disturbance. Less is known about the ecological role of diseases in south-central and interior forests, however diseases appear to be agents of small-scale disturbance altering ecological processes in spruce and hardwood forests.

Forest practices can be used to alter the incidence of diseases to meet management objectives. Two of the principal types of conifer disease that influence forest structure in Alaska, heart rot and dwarf mistletoe, can be managed to predictable levels. If reducing disease to minimal levels is a management objective, then both heart rot and mistletoe can be largely eliminated through clearcut harvesting and even-aged management. However, to reduce disease to minimal levels in all instances is to diminish the various desirable characteristics of forest structure and ecosystem functions that they influence. Research indicates that various silvicultural techniques can be used to retain structural and biological diversity by manipulating these diseases to desired levels. Since heart rot in coastal stands is associated with natural bole scars and top breakage, levels of heart rot can be manipulated by controlling the incidence of bole wounding and top breakage during stand entries for timber removal. Levels of dwarf mistletoe can be manipulated through the distribution, size, and infection levels of residual trees that remain after harvest. Our ongoing research indicates that the incidence and effects of these diseases will vary through time in a predictable manner by whatever silvicultural strategy is used.

Research is currently underway in south-central and interior Alaska to assess the economic and ecological impacts of root diseases. Root diseases are difficult to detect, remain active on site in trees and stumps for decades, infect multiple age classes, and cause substantial volume loss. Ecologically, root diseases create canopy gaps that contribute to biodiversity, provide wildlife habitat, and alter successional processes. Elimination of root rot from an infected site is challenging because the diseased material is primarily located in buried root systems. Establishment of nonhost material within root rot centers is an effective option for manipulating levels of root disease. Ongoing research on the relationship between species composition and root disease incidence in south-central and interior Alaska will provide important information to forest managers for both ecological and economic considerations for disease management.

Figure 27. *Decay fungi play vital roles in recycling nutrients and producing habit.*

Table 4. Suspected ecological effects of common diseases in Alaskan forests.

Disease	Ecological Function Altered			
	Structure	Composition	Succession	Wildlife Habitat
Stem Diseases				
Dwarf Mistletoe	●	◗	◗	●
Hemlock Cankers	❍	◗	❍	◗
Hardwood Cankers	◗	◗	◗	❍
Spruce Broom Rust	◗	❍	❍	●
Hemlock Bole Fluting	❍	❍	❍	◗
Western Gall Rust	❍	❍	❍	❍
Heart Rots				
(Many Species)	●	◗	●	●
Root Diseases				
(Several Species)	◗	●	●	◗
Foliar Diseases				
Spruce Needle Rust	❍	❍	❍	❍
Spruce Needle Blights	❍	❍	❍	❍
Hemlock Needle Rust	❍	❍	❍	❍
Cedar Foliar Diseases	❍	❍	❍	❍
Hardwood Leaf Diseases	❍	❍	❍	❍
Shoot Diseases				
Sirococcus Shoot Blight	❍	❍	❍	❍
Shoot Blight of Yellow-Cedar	❍	◗	❍	❍
Declines				
Yellow-Cedar Decline	●	●	●	◗
Animal Damage				
Porcupines	◗	❍	❍	◗
Brown Bears	◗	❍	❍	◗
Moose	◗	◗	❍	◗

Effects by each disease of disorder are qualified as:
negligible or minor effect = ❍;
some effect = ◗;
dominant effect = ●.

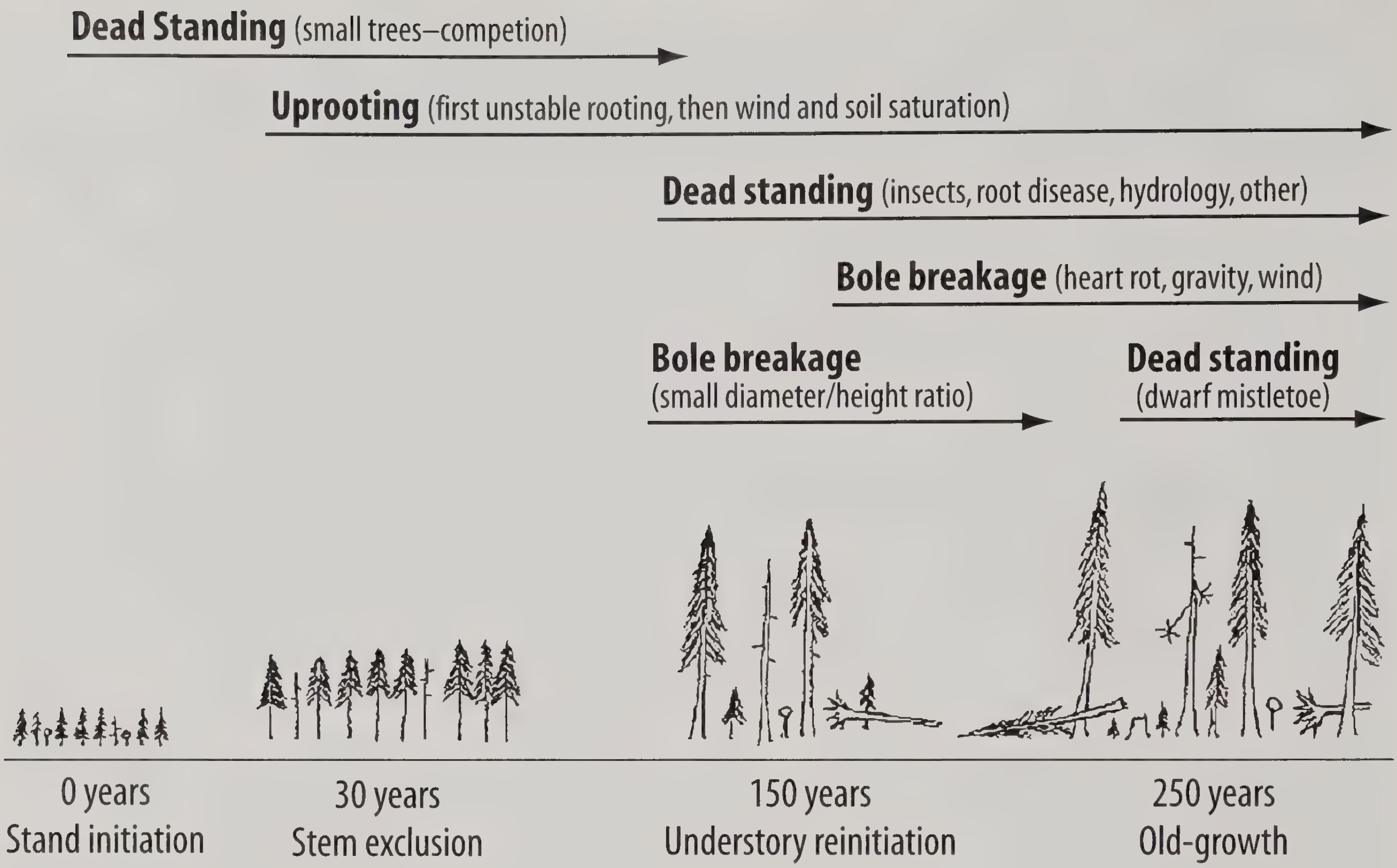


Figure 28. *Stages of stand development and associated forms of tree mortality following catastrophic disturbance (e.g., clear-cut or storm). Competition causes most mortality in young stands and trees usually die standing. Disease in the form of heart rot plays an active role in small-scale disturbance in the third, transitional stage and then is a constant factor in the maintenance of the old-growth stage. The time scale that corresponds to stages of stand development varies by site productivity. Many old-growth structures and conditions may be present by 250 years on some sites in southeast Alaska. The old-growth stage may persist for very long periods of time in protected landscape positions.*

Stem Diseases

Hemlock Dwarf Mistletoe

Arceuthobium tsugense (Rosendhal) G.N. Jones

Hemlock dwarf mistletoe is an important disease of western hemlock in unmanaged old-growth stands throughout southeast Alaska as far north as Haines. Although the range of western hemlock extends to the northwest along the Gulf of Alaska, dwarf mistletoe is absent from Cross Sound to Prince William Sound. The incidence of dwarf mistletoe in southeast Alaska varies in old-growth hemlock stands from stands in which every mature western hemlock is severely infected to other stands in which the parasite is absent. The dominant small-scale (canopy gap) disturbance pattern in the old forests of coastal Alaska favors the short-range dispersal mechanism of hemlock dwarf mistletoe and may explain the common occurrence of the disease here. Infection of Sitka spruce is uncommon and infection of mountain hemlock is rare. The disease is uncommon on any host above elevations of approximately 1,000 feet. Heavily infected western hemlock trees have branch proliferations "witches' brooms," bole deformities, reduced height and radial growth, less desirable wood characteristics, greater likelihood of heart rot, top-kill, and death. We have found the aggressive heart rot fungus, *Phellinus hartigii*, associated with large mistletoe brooms on western hemlock.

These symptoms are all potential problems in stands managed for wood production. Growth loss in heavily infested stands can reach 40 percent or more. On the other hand, witches' brooms, wood decay associated with bole infections, and scattered tree mortality can result in greater diversity of forest structure and increased animal habitat. Witches' brooms may provide hiding or nesting habitats for birds or small mammals, although this topic has not been adequately researched in Alaska. The inner bark of swellings and the seeds and shoots of the parasitic plants are nutritious and often consumed by small mammals (e.g., most likely flying squirrels). However, heavily infected hemlock stands can begin to decline and collapse to the extent that vertical structural diversity and animal habitat are diminished. Stand composition is altered when mixed-species stands are heavily infected; growth of resistant species such as Sitka spruce and cedar is enhanced.

Figure 29. *Hemlock dwarf mistletoe is a parasitic plant that causes the host tree to form "broom" like branches.*

Spread of the parasite into young-growth stands that regenerate following "clear cutting" is typically by: 1) infected nonmerchantable hemlock trees (residuals) which are sometimes left standing in cutover areas, 2) infected old-growth hemlocks on the perimeter of cutover areas, and 3) infected advanced reproduction. Residual trees may play the most important role in the initial spread and long-term mistletoe development in young stands. Managers using alternative harvest techniques (e.g., large residuals left standing in clearcuts, small harvest units, or partial harvests) should recognize the potential reduction in timber volume and value from hemlock dwarf mistletoe under some of these silvicultural scenarios. But substantial reductions to timber are only associated with very high disease levels. High levels of hemlock dwarf mistletoe will only result if numerous, large, intensely infected hemlocks are well distributed after harvest. Mistletoe management appears to be a good tool in balancing several resource objectives. Selective harvesting techniques will be the silvicultural method for maintaining desirable levels of this disease if management intends to emphasize structural and biological diversity along with timber production.

Spruce Broom Rust

Chrysomyxa arctostaphyli Diet.

Broom rust is common on spruce throughout south-central and interior Alaska, but is found in only several local areas of southeast Alaska (e.g., Halleck Harbor area of Kuiu Island and Glacier Bay). The disease is abundant where spruce grows near the alternate host, bearberry or kinnikinnick (*Arctostaphylus uva-ursi*) in Alaska. The fungus cannot complete its life cycle unless both hosts (spruce and bearberry) are present.

Infections by the rust fungus result in dense clusters of branches or witches' brooms on white, Lutz, Sitka, and black spruce. The actual infection process may be favored during specific years, but the incidence of the perennial brooms changes little from year to year. The disease may cause slowed growth of spruce, and witches' brooms may serve as entrance courts for heart rot fungi, including *Phellinus pini*.

Ecologically, the dense brooms provide important nesting and hiding habitat for birds and small mammals. In interior Alaska, research on northern flying squirrels suggests that brooms in white spruce are an important habitat feature for communal hibernation and survival in the coldest periods of winter.

Western Gall Rust

Peridermium harknessii J.P. Moore

Infection by the gall rust fungus *P. harknessii* causes spherical galls on branches and main boles of shore pine. The disease was common throughout the distribution of pine in Alaska in 2002. Infected pine tissues are swollen but not always killed by the rust fungus. Another fungus, *Nectria macrospora*, colonized and killed many of the pine branches with *P. harknessii* galls this year. The combination of the rust fungus and *N. macrospora* frequently caused top-kill. The disease, although abundant, does not appear to have a major ecological effect in Alaskan forests.

Figure 30. *Western gall rust on a shore pine branch.*

Figure 31. ***Fomitopsis pinicola*** *is an important heart rot fungus in live trees, but also the dominant decomposer of dead conifer trees.*

Heart Rots of Conifers

Heart rot decay causes enormous loss of wood volume in Alaskan forests. Approximately one-third of the old-growth timber volume in southeast Alaska is defective largely due to heart rot fungi. These extraordinary effects occur where long-lived tree species predominate, such as old-growth forests in southeast Alaska. The great longevity of individual trees allows ample time for the slow-growing decay fungi to cause significant amounts of decay. Wood decay fungi play an important role in the structure and function of coastal old-growth forests where fire and other forms of catastrophic disturbance are uncommon. By predisposing large old trees to bole breakage, these fungi serve as important disturbance factors that cause small-scale canopy gaps. All major tree species in southeast Alaska are susceptible to heart rot decay and bole breakage.

In south-central and interior Alaska heart rot fungi cause considerable volume loss in mature white spruce and hardwood forests. In the boreal forests, large-scale disturbance agents, including wildfire, insect outbreaks (e.g., spruce beetle), and flooding, are key factors influencing forest structure and composition. Although, small-scale disturbances from the decay fungi are less dramatic, they have an important influence on altering biodiversity and wildlife habitat at the individual tree and stand level.

Heart rot fungi enhance wildlife habitat indirectly by increasing forest diversity through gap formation and more directly by creating hollows in live trees or logs for species such as bears and cavity nesting birds. Wood decay in both live and dead trees

is a center of biological activity, especially for small organisms. Wood decay is the initial step in nutrient cycling of wood substrates, has associated bacteria that fix nitrogen, and contributes large masses of stable structures (e.g., partially modified lignin) to the humus layer of soils.

The importance of decay fungi in managed young-growth conifer stands is less certain. Wounds on live trees caused by logging activities allow for the potential of decay fungi to cause appreciable losses. Heart rot in managed stands can be manipulated to desirable levels by varying levels of bole wounding and top breakage during stand entries. In some instances, bole breakage is sought to occur in a specific direction (e.g., across streams for coarse woody debris input). Artificially wounding trees on the side of the bole that faces the stream can increase the likelihood of tree fall in that direction. In southeast Alaska, we investigated how frequently fungi enter wounds of different sizes and the rate of subsequent decay in these wounded trees. Generally, larger, deeper wounds and larger diameter breaks in tops result in a faster rate of decay. Results indicate that heart rot development is much slower in southeast Alaska than areas studied in the Pacific Northwest.

Wood decay fungi decompose branches, roots, and boles of dead trees; therefore, they play an essential role in recycling wood in forests. However, sap rot decay also routinely and quickly develops in spruce trees attacked by spruce beetles. Large amounts of potentially recoverable timber volume are lost annually due to sap rot fungi on the Kenai Peninsula. Significant volume loss from sap rot fungi typically occurs several years after tree death. The most common sap rot fungus associated with spruce beetle-caused mortality is *Fomitopsis pinicola*, the red belt fungus.

A deterioration study of beetle-killed trees was initiated on the Kenai Peninsula in 2002. The objective was to fill information gaps in our understanding on the rate beetle-killed trees decompose. This information is critical for the future planning of salvage, fire risk, impacts on soil fertility, and wildlife habitat.

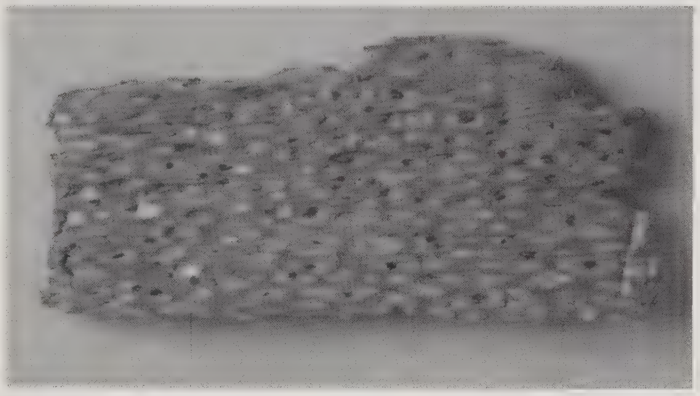


Figure 32. *White pocket rot caused by* ***Phellinus pini***.

Table 5. Common wood decay fungi on live trees in Alaska

	Tree Species Infected				
Heart and butt rot fungi*	**Western hemlock**	**Sitka spruce**	**Western Red cedar**	**White/Lutz spruce**	**Mountain hemlock**
Laetiporus sulphureus	X	X		X	X
Phaeolus schweinitzii	X	X		X	
Fomitopsis pinicola	X	X		X	X
Phellinus hartigii	X				
Phellinus pini	X	X		X	X
Ganoderma spp.	X	X		X	
Coniophora spp.				X	X
Armillaria spp.	X	X	X	X	X
Inonotus tomentosus				X	
Heterobasidion annosum	X	X			
Ceriporiopsis rivulosa			X		
Phellinus weirii			X		
Echinodontium tinctorium					X

* Some root rot fungi were included in this table because they are capable of causing both root and butt rot of conifers.

Stem Decay of Hardwoods

Stem decay is the most important cause of volume loss and reduced wood quality in Alaskan hardwood species. In south-central and interior Alaska incidence of stem decay fungi increases as stands age and is generally high in mature stands. Research indicates that the most reliable sign of decay is the presence of fruiting bodies (mushrooms or conks) on the stem. Frost cracks, broken tops, dead-broken branches, and poorly healed trunk wounds provide an entrance court for decay fungi. Stem decay fungi will limit harvest rotation age of forests that are managed for wood production purposes. Research in paper birch forests has identified the most important stem decay fungi and assessed decay incidence as related to stand age and presence of decay indicators.

Ecologically, stem decay fungi alter stand structure and composition and appear to be important factors in the transition of even-aged hardwood forests to mixed species forests. Bole breakage of hardwoods creates canopy openings, allowing release of understory conifers. Trees with stem decay, broken tops, and collapsed stems are preferentially selected by wildlife for cavity excavation. Several mammals, including the northern flying squirrel, are known to use tree cavities year-round for nest and cache sites.

Figure 33. *Gilled mushrooms of* ***Armillaria sinapina***.

In south-central and interior Alaska the following fungi are the primary cause of wood decay in live trees:

Paper birch

- *Phellinus igniarius*
- *Inonotus obliquus*
- *Pholiota* sp.
- *Armillaria* sp.

Trembling aspen

- *Phellinus tremulae*
- *Pholiota* sp.
- *Ganoderma applanatum*
- *Armillaria* sp.

A number of fungi cause stem decay in balsam poplar, black cottonwood, and other hardwood species in Alaska.

Shoot Blights and Cankers

Sirococcus Shoot Blight

***Sirococcus strobilinus* Pruess.**

The shoots of young-growth western hemlocks were killed in moderate levels by the blight fungus *S. strobilinus* in southeast Alaska during 2002. Small mountain hemlock was found attacked severely in some forest and urban locations. Sitka spruce were attacked, but less frequently and less severely. Thinning may be of some value in reducing damage by the fungus as thinned stands have fewer infections than unthinned stands, but some trees in exposed locations are also attacked.

This disease is typically of minimal ecological consequence because infected trees are not often killed and young hemlock stands are so densely stocked. Species composition may be altered to some degree where trees other than western or mountain hemlock may be favored by the disease.

Shoot Blight of Yellow-cedar

***Apostrasseria* sp.**

Yellow-cedar regeneration suffered infection and shoot blight by the fungus *Apostrasseria* sp. in southeast Alaska in 2002 as it does every year. The disease, however, does not affect mature cedar trees. Attack by the fungus causes terminal and lateral shoots to be killed back 10 to 20 cm on seedlings and saplings during winter or early spring. Entire seedlings up to 0.5m tall are sometimes killed. The

fungus that causes the disease, *Apostrasseria* sp., is closely related to other fungi that cause disease on plants under snow. The severe late spring frost of 2002 that affected so many small yellow-cedar trees may have masked some of the disease this year.

The fungus *Herpotrichia juniperi* is often found as a secondary invader on seedling tissues that die from any of these causes.

This shoot blight disease probably has more ecological impact than similar diseases on other host species because the natural regeneration of yellow-cedar is limited in many areas. By killing the leaders of yellow-cedar seedlings and diminishing their ability to compete with other vegetation, the pathogen reduces the regeneration success of yellow-cedar and thereby alters species composition.

Canker Fungi

***Cryptosphaeria populina* (Pers.) Sacc.**
***Cenangium singulare* (Rehm.) D. & Cash**
***Ceratocystis fimbriata* Ell. & Halst.**
***Cytospora chrysosperma* Pers. ex Fr.**
***Nectria galligena* Bres.**

All the canker-causing fungi were at endemic levels in 2002. These fungi cause perennial stem deforming cankers and wood decay of many hardwood species, particularly trembling aspen, in south-central and interior Alaska. Although most are considered weak parasites, *C. singulare* can girdle and kill a tree in three to ten years. *N. galligena* causes perennial "target" cankers particularly on paper birch. A low incidence of wood decay is associated with infection by this canker fungus. Ecologically, canker fungi alter stand structure, composition, and successional patterns through trunk deformity and bole breakage.

Hemlock Canker

The hemlock canker disease was active in 2002, continuing the 2001 outbreak observed in several areas in southeast Alaska. The current outbreak was evident far away from roads, especially in young-growth forests of Prince of Wales Island and the shores of Etolin Island. One notable outbreak was in thinned young-growth western hemlock near Polk Inlet were intended crop trees had been killed by the disease. In past outbreaks, it has been common along unpaved roads on Prince of Wales Island, Kuiu Island (Rowan Bay road system), Chichagof Island (Corner Bay road system), and near Carroll Inlet

Figure 34. *Nectria galligena on paper birch.*

on Revillagigedo Island. We have also observed the canker in several roadless areas.

The causal agent has not been conclusively determined. Road dust and a fungus (that we have isolated to pure culture but not identified) appear to be responsible for outbreaks of this disease. Finding the disease well away from roads has us questioning the role of dust in the development of the disease, however. Ecologically, modification of stand composition and structure are the primary effects of hemlock canker. Tree species, other than western and mountain hemlock (i.e., often Sitka spruce) are resistant and benefit from reduced competition. Wildlife habitat, particularly for deer, may be enhanced where the disease kills understory hemlock which tends to out-compete the more desirable browse vegetation.

Foliar Diseases

Spruce Needle Rust

Chrysomyxa ledicola Lagerh.
Chrysomyxa weirii Jacks.

Spruce needle rust, caused by *C. ledicola*, occurred at endemic levels across the State in 2002. The disease can be found wherever spruce and Labrador tea coexist on wet, boggy soils. Up to 100 percent of current-year's spruce needles were infected in many of these areas. With missing needles from the outbreaks in the last few years, spruce trees have had a rather thin appearance. Infection levels were quite low in 2002, however, and these trees are acquiring a fuller crown.

The spores that infect spruce needles are produced on the alternate host, Labrador tea (*Ledum* spp. although a genus change to *Rhododendron* spp. is being debated), a plant that is common in boggy areas; thus the disease on spruce is most pronounced in these boggy (muskeg) areas. Although the disease can give spruce trees the appearance of being nearly dead, trees rarely die of this disease even in years of intense infection.

On Sitka spruce, the primary ecological consequence of the disease may be to reduce tree vigor of a species already poorly adapted to boggy sites. Repeated infection of spruce may alter forest composition by favoring other tree species.

The foliar rust fungus *C. weirii* was found sporulating on one-year-old Sitka spruce needles in several areas of southeast Alaska during spring. Unlike most other rust fungi, no alternate host is necessary to complete its life cycle. Little ecological or economic impact results from this disease.

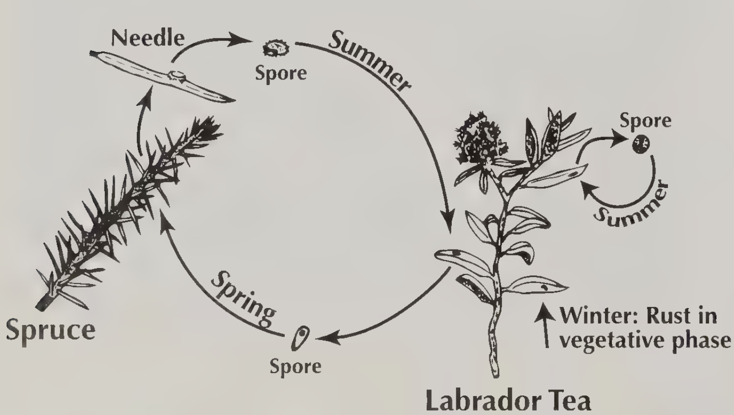


Figure 35. *The life cycle of* ***C. ledicola*** *involves two host plants: spruce and Labrador tea.*

Figure 36. *Yellow fruiting bodies of* ***Chrysomyxa ledicola*** *can be seen on the current year needles of this spruce.*

Hemlock Needle Rust

Pucciniastrum vaccinii (Rab.) Joerst.

Hemlock needle rust was found at low endemic levels in 2002 The last year of high levels of this disease was in 1996, when the disease was most damaging near Yakutat. There, it caused defoliation of western hemlock, especially on trees growing adjacent to harvested sites. Elsewhere, infected needles were found, but hemlock trees were not heavily defoliated. The alternate hosts for the rust fungus include several blueberry species (*Vaccinium*). An infection level usually return to endemic levels in a year or so and the disease is not expected to have major ecological change.

Foliage Diseases of Cedars

Gymnosporangium nootkatense Arth.
Didymascella thujina (Durand) Maire

Two fungi that infect the foliage of cedar, *G. nootkatense* on yellow-cedar and *D. thujina* on western red cedar, occurred at endemic levels this year. *G. nootkatense* was found at the very northwest limits of the natural range of yellow-cedar in Prince William Sound several years ago. *D. thujina* was the more

damaging of the two fungi and was common wherever its host was found. Neither fungus resulted in severe defoliation or death of cedar trees. Homeowners sometimes complain about *D. thujina* because infection can be severe enough to alter the general appearance of ornamental red-cedar trees. Neither disease has major ecological effects.

Spruce Needle Blights

***Lirula macrospora* (Hartig) Darker**
***Lophodermium picea* (Fuckel) Hšhn.**
***Rhizosphaera pini* (Corda) Maubl.**

All of these needle diseases occurred at low or moderate levels in 2002. The fungus *L. macrospora* is the most important needle pathogen of spruce. Severely infected trees could be found in a few areas, but they were not common. *L. picea* was present at low infection levels in 2002. This disease is more typical of larger, older trees of all spruce species in Alaska. *R. pini* continued at endemic levels after causing damage several years ago in coastal Alaska. The dead older needles closely resemble damage caused by spruce needle aphid. Microscopic observation of the tiny fruiting bodies erupting from stomata on infected needles is necessary for proper identification.

Figure 37. ***Lirula macrospora*** *fruiting bodies on spruce needles.*

The primary impact of these needle diseases is generally one of appearance. They can cause severe discoloration or thinning of crowns but typically have only negligible ecological consequence. However, repeated heavy infections may slow the growth of spruce and benefit neighboring trees, thereby altering species composition to some degree.

Pine Needle Blight

***Lophodermium seditiosum* (Min., Sta.& Mill.)**

The fungus *Lophodermium seditiosum* was found infecting native shore pine in ornamental settings in the Juneau area during 2002. Some trees were significantly defoliated. This disease will be monitored in the next few years.

Root Diseases

Three important tree root diseases occur in Alaska: tomentosus root rot; annosus root disease, and armillaria root disease. The laminated root disease caused by a form of the fungus *Phellinus weirii*, so important in some western forests of British Columbia, Washington, and Oregon, is not present in Alaska. A non-root disease form of the fungus is present in southeast Alaska, where it causes a white rot in western red-cedar, contributing to the very high defect levels in this tree species.

Although relatively common in Alaskan forests, root diseases are often misdiagnosed or overlooked. Diagnosing root disease can be challenging because the infected tissue is primarily below ground in roots and infected trees may lack above ground symptoms. Identification of a root disease should not be made solely on the basis of crown symptoms. Above ground symptoms, such as chlorotic foliage, stress cone crop, and reduced branch growth can be caused by a wide array of stress factors other than root diseases.

Root disease pathogens affect groups of trees in progressively expanding disease centers. Typically, disease pockets contain dead trees in the center and living, but infected trees in various stages of decline, at the edges. Root disease fungi spread most efficiently from tree to tree through root contacts. Infected trees are prone to uprooting, bole breakage, and outright mortality due to the extensive decay of root systems and the lower tree bole. Volume loss attributed to root diseases can be substantial, up one third of the gross volume. In managed stands, root

rot fungi are considered long-term site problems because they can remain alive and active in large roots and stumps for decades, impacting the growth and survival of susceptible host species on infected sites.

Ecologically, root diseases are considered natural, perhaps essential, parts of the forest altering stand structure, composition, and increasing plant community diversity through canopy openings and scattered mortality. Resistant tree species benefit from reduced competition within infection centers. Wildlife habitat may be enhanced by small-scale mortality centers and increased volume of large woody downed material.

Armillaria Root Disease

Armillaria spp.

Several species of *Armillaria* occur in the coastal forests of southeast Alaska, but in general, these species are less-aggressive, saprophytic decomposers that only kill trees when they are under some form of stress. Studies in young, managed stands indicate that *Armillaria* sp. can colonize stumps, but will not successfully attack adjacent trees. *Armillaria* may be an important agent in the death and decay of red alder. A few red alder trees were found apparently killed by *Armillaria* in 45-year old mixed hardwood-conifer forests in the Maybeso Valley of Prince of Wales Island. Many more affected red alders were found in a 110 year-old mixed forest on Baranof Island, indicating that the disease may be important in the senescence of alder as these stands age.

Several species of *Armillaria* occur in south-central and interior Alaska some attack conifers while others attack hardwoods. Most species appear to be weak pathogens invading trees under some form of stress. Research is currently underway to determine the species present and their impacts in the boreal forests.

Tomentosus Root Disease

Inonotus tomentosus (Fr.) Teng.

I. tomentosus causes root and butt-rot of white, Lutz, Sitka, and black spruce. The fungus may also attack lodgepole pine and tamarack. Hardwood trees are not considered hosts. The disease appears to be widespread across the native range of spruce in south-central and interior Alaska but to date has not been found in southeast Alaska.

Research conducted in Canada indicates that volume loss in the butt log of older infected trees can be substantial, up one third of the gross volume. In south-central Alaska, a volume loss study was initiated in 2001 to quantify the butt cull losses due to this root disease. A second study, with similar objectives, was initiated in interior Alaska in 2002.

Spruce trees of all ages are susceptible to infection through contact with infected roots. Infected trees exhibit growth reduction or mortality, depending on age. Younger trees may be killed outright while older trees may persist in a deteriorating condition for many years. Trees with extensive root and butt decay are prone to uprooting and bole breakage. Individual mortality centers (groups of infected trees) are typically small, however, coalescing centers can occupy large areas.

Research indicates that *I. tomentosus* will remain alive in colonized stumps for at least three decades, and successfully attack adjacent trees through root contacts. Thus, spruce seedlings planted in close proximity of infected stumps are highly susceptible to infection through contacts with infected roots. Recognition of this root disease is particularly important in managed stands where natural regeneration of white and Lutz spruce is limited and adequate restocking requires planting. The incidence of this root rot is expected to increase on infected sites that are replanted with spruce.

Tomentosus root disease can be managed in a variety of ways depending on management objec-

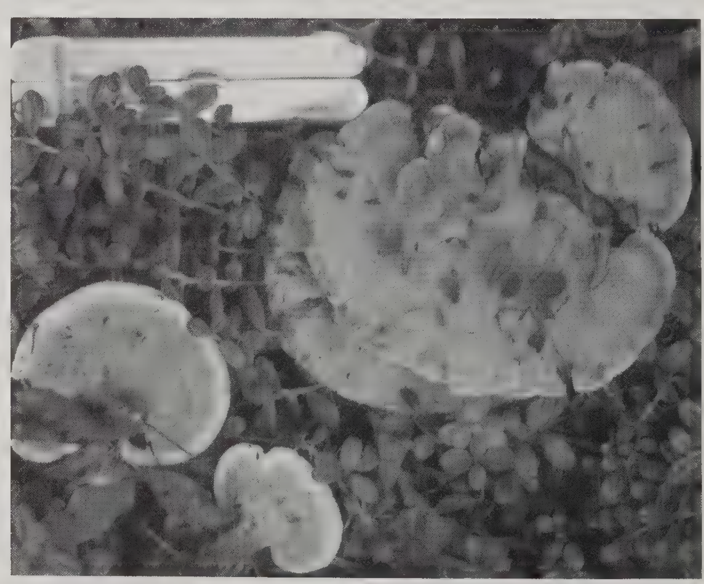


Figure 38. *Leathery annual fruiting bodies of* ***Inonotus tomentosus****.*

tives. Options include: establishment of non-susceptible species in root rot centers (i.e., hardwood trees), avoid planting susceptible species within close proximity of diseased stumps, and removal of diseased stumps and root systems. Pre- and post harvest walk-through surveys in managed stands can be used to stratify the area by disease incidence. Research is currently underway to assess mortality in young growth stands and to determine site factors that influence disease incidence and severity.

Annosus Root & Butt Rot

Heterobasidion annosum (Fr.) Bref.

Annosus commonly causes root and butt-rot in old-growth western hemlock and Sitka spruce forests in southeast Alaska. To date, *Heterobasidion annosum* has not been documented in south-central or interior Alaska.

Elsewhere in the world, spores of the fungus are known to readily infect fresh stump surfaces, such as those found in clearcuts or thinned stands. Studies in managed stands in southeast Alaska, however, indicate limited stump infection and survival of the fungus. Thus, this disease poses minimal threat to young managed stands from stump top infection.

Reasons for the limited stump infection may be related to climate. High rainfall and low temperatures, common in Alaska's coastal forests, apparently hinder infection by spores.

Yellow-cedar Decline

Decline and mortality of yellow-cedar persists as one of the most dramatic forest problems in Alaska. Approximately 490,000 acres of decline have been mapped during aerial detection surveys. Extensive mortality occurs in a wide band from western Chichagof and Baranof Islands to the Ketchikan area. In 2002, about 3,000 acres were mapped as very active, that is, they had high concentrations of dying trees with off-color crowns. The remainder of the acreage is dominated by concentrations of dead standing trees.

All research suggests that contagious organisms are not the primary cause of this extensive mortality. Some site factor, probably associated with poorly drained anaerobic soils, appears to be responsible for initiating and continuing cedar decline. Two hypotheses have been proposed to explain the primary cause of death in yellow-cedar decline:

- Toxins are produced by decomposition in the wet, organic soils, or through cation mobilization, or
- Shallow fine roots are damaged from freezing, associated with climatic warming and reduced insulating snow pack in the last century.

These hypotheses are developed in some detail (Hennon and Shaw 1994, 1997). Whatever the primary cause of this mysterious decline, all available information indicates that it is probably a naturally occurring phenomenon. In 2002, we initiated a study to monitor soil temperature, soil chemistry, and hydrology in two forests (Poison Cove and Goose Cove) along Peril Strait to evaluate these ideas. A scientist from the Northeast Forest Research Station is also involved in testing the cold tolerance of yellow-cedar and associate tree species on these sites.

Research suggests that the total acreage of yellow-cedar decline has been increasing very gradually; the slow increase in area has been a result of the expansion of existing decline (less than 3 feet per year). Most stands contain trees that died up to 100 years ago (snags still standing), as well as recently killed cedars, dying cedars (with yellow, red, or thinning crowns), healthy cedars, and other tree species.

Ground surveys show that 65 percent of the basal area of yellow-cedar is dead on this acreage. Other tree species are affected in different ways: on some sites they produce increased growth, presumably due to less competition, and on other sites they experience slowed growth and mortality due to deteriorating site conditions (poor drainage). Species change to western hemlock and mountain hemlock and large increases in understory biomass accumulation for brushy species appear to be occurring in some stands where decline has been ongoing for up to a century.

The primary ecological effect of yellow-cedar decline is to alter stand structure (i.e., addition of numerous snags) and composition (i.e., yellow-cedar diminishing and other tree species becoming more numerous) that leads to eventual succession favoring other conifer species. We speculate that the actual successional trends following overstory cedar death may vary according to the potential productivity of the site, which is governed by landscape position and

Figure 39. *Dead yellow cedar trees retain wood quality, even many years after death.*

Map 9. Yellow-cedar decline in southeast Alaska.

Table 6. Acreage affected by yellow-cedar decline in southeast Alaska in 2002 by ownership.

National Forest	**451,011**
Admiralty National Monument	5,362
Admiralty I	5,362
Craig Ranger District	29,152
Dall & Long I	931
Prince of Wales I	28,221
Hoonah Ranger District	1,028
Chichagof I	1,028
Juneau Ranger District	827
Mainland	827
Ketchikan Ranger District	32,744
Annette Duke I	1,770
Mainland	15,019
Revillagigedo & Gravina I	15,955
Misty Fiords National Monument	25,379
Mainland	16,390
Revillagigedo I	8,989
Petersburg Ranger District	153,378
Kuiu I	65,819
Kupreanof I	72,015
Mainland	8,056
Mitkof I	5,172
Woewodski I	2,315
Sitka Ranger District	110,865
Baranof I	48,471
Chichagof I	35,534
Kruzof I	26,860
Thorne Bay Ranger District	45,516
Heceta I	892
Kosciusko I	11,407
Prince of Wales I	33,217
Wrangell Ranger District	46,760
Etolin I	18,690
Mainland	13,765
Woronofski I	395
Wrangell I	9,339
Zarembo I	4,571
Native Land	**19,178**
Admiralty NM	55
Baranof I	256
Chichagof I	818
Dall and Long I	1,349
Kruzof I	143
Kuiu I	515
Kupreanof I	3,991
Mainland	876
Revillagigedo I	2,301
Prince of Wales I	8,809
Wrangell I	66
Other Federal	**801**
Baranof I	362
Chichagof I	3
Prince of Wales I	88
Etolin I	35
Kuiu I	176
Kupreanof I	138
State and Private Land	**21,224**
Admiralty I	9
Baranof & Kruzof I	3,399
Chichagof I	1,161
Dall and Long I	62
Gravina I	1,351
Kosciusko & Heceta I	154
Kuiu I	601
Kupreanof and Mitkof I	2,646
Northern Mainland	42
Central Mainland	2,124
Southern Mainland	862
Prince of Wales I	3,487
Revillagigedo I	4,190
Wrangell I	1,137
Total Land Affected	***492,215**

substrate properties. The creation of numerous snags is probably not particularly beneficial to cavity-using animals because yellow-cedar wood is less susceptible to decay. Region-wide, this excessive mortality of yellow-cedar may lead to diminishing populations (but not extinction) of yellow-cedar, particularly when the poor regeneration of the species is considered.

The large acreage of dead yellow-cedar and the high value of its wood suggest opportunities for salvage. Cooperative studies with the Wrangell Ranger District, the Forest Products Laboratory in Madison, Wisconsin, Oregon State University, and State and Private Forestry are investigating the mill-recovery and wood properties of snags of yellow-cedar that have been dead for varying lengths of time. This work includes wood strength properties, durability (decay resistance), and heartwood chemistry.

* Acreage by ownership was tabulated using Alaska land status data from State of Alaska, Department of Natural Resources. Changes in acreage figures are due to a change in the resource, refined sketch-mapping or changes in GIS techniques.

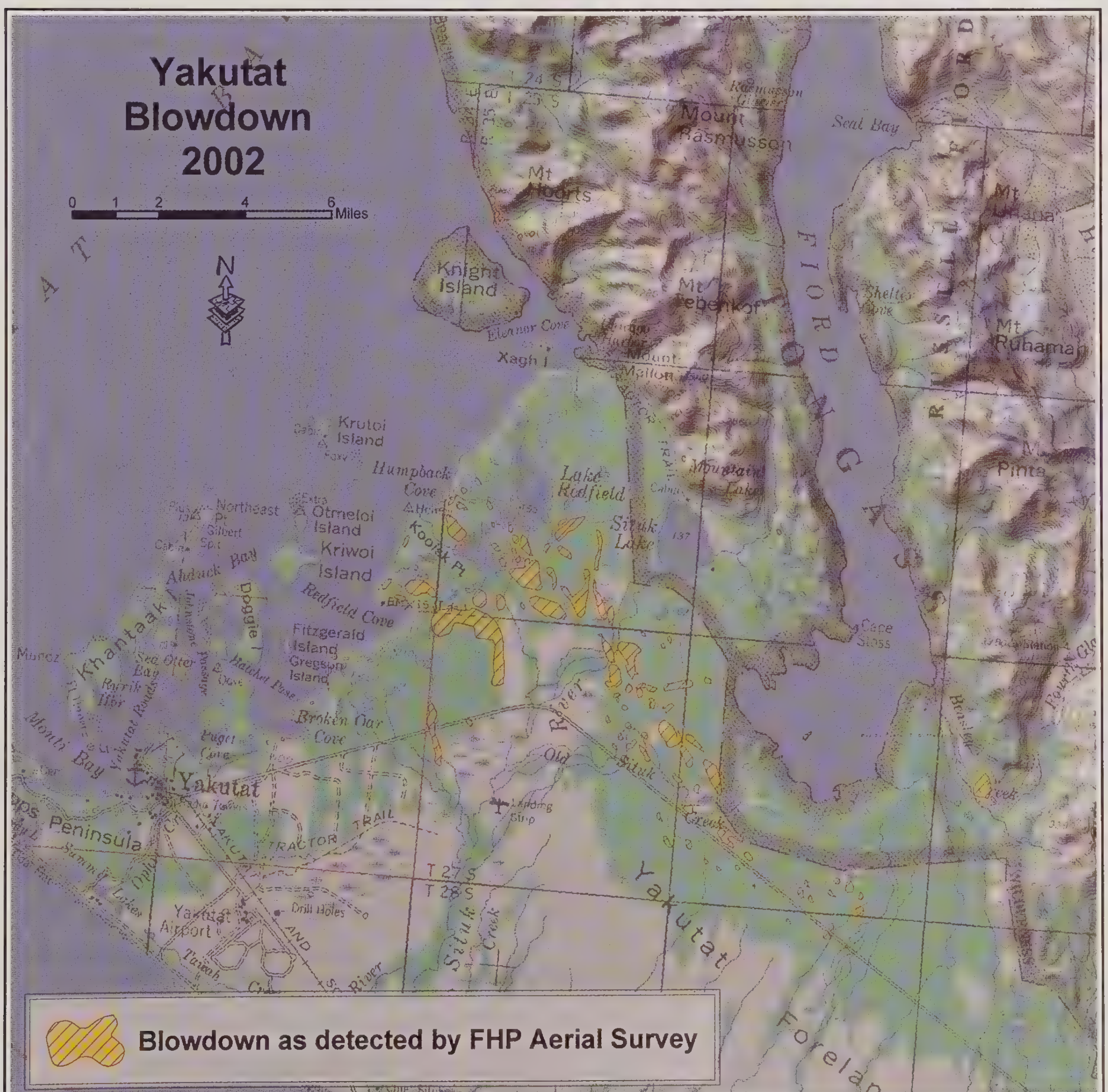
Little is known about wildlife use and dependency on yellow-cedar forests. We would like to evaluate birds' use of each of the snag classes as nesting or feeding habitat. In a companion study that we have initiated, we are investigating the insect community on dead cedars; insects on recently killed trees may be an important prey source for insectivorous birds.

Blowdown

During a November 2001 storm, a 3,580 acre blowdown event occurred in the Yakutat Forelands just south and southwest of Russell Fiord. During the winter of 1981 a similar blowdown event occurred in the same area on 3,500 acres and Spruce bark beetle populations subsequently expanded to outbreak levels, killing 22 percent of the surrounding spruce in the following 2-5 years.

In August of 2002 these recent windthrown trees were examined for the presence of bark beetles and ambrosia beetles. No spruce beetles, *Dendroctonus rufipennis* (Kby.), were found in any of the trees that were windthrown in November 2001. Many of the trees that were windthrown had some intact roots that allowed them to remain green and continue to grow. In most cases, blowdown patches were small enough and shading great enough that foliage and phloem tissue remained green and healthy looking. These trees may continue to be susceptible to spruce beetle attack in 2003 and will be monitored in 2003 and 2004.

Map 10. Scattered blowdown occurred northwest of Yakutat.



Winter Damage

A late spring frost damaged vegetation throughout southeast Alaska in 2002. Many conifers species and evergreen broadleaf plants expressed shoot dieback as the result of warm spring temperatures followed by a cold spell in early April. The actual freezing injury probably occurred around April 2 and 3, 2002. Native conifers damaged included western and mountain hemlock, western red cedar, yellow-cedar. Smaller trees appeared to be more severely affected than larger ones. Many ornamental conifers were damaged as well and some were killed outright. Above ground portions of salal were damaged in exposed areas of southern southeast Alaska. Salmonberry canes were damaged or killed throughout southeast Alaska, usually resulting in delayed bud burst or new shoots emerging from the ground. The influence of this freezing event on fruit production of forest plants is not known.

Hemlock Fluting

Deeply incised grooves and ridges extending vertically along boles of western hemlock characterize hemlock fluting. Fluting is distinguished from other characteristics on tree boles, such as old callusing wounds and root flaring, in that fluting extends near or into the tree crown and fluted trees have more than one groove. Bole fluting is common on western hemlock in many areas of southeast Alaska. This condition reduces the value of hemlock logs because they yield less saw log volume and bark is contained in some of the wood. The cause of fluting is not completely understood, but associated factors include: increased wind-firmness of fluted trees, shallow soils, and a triggering mechanism during growth release (e.g., some stand management treatments). The asymmetrical radial growth appears to be caused by unequal distribution of carbohydrates due to the presence of dead branches. Researchers have documented the development of fluting in young hemlock stands that regenerated following clearcut harvesting or other disturbance. After several centuries, fluting sometimes is no longer outwardly visible in trees because branch scars have healed over and fluting patterns have been engulfed within the stem.

Bole fluting has important economic impact, but may have little ecological consequence beyond adding to wind firmness. The deep folds on fluted stems of western hemlock may be important habitat for some arthropods and the birds that feed upon them (e.g., winter wren).

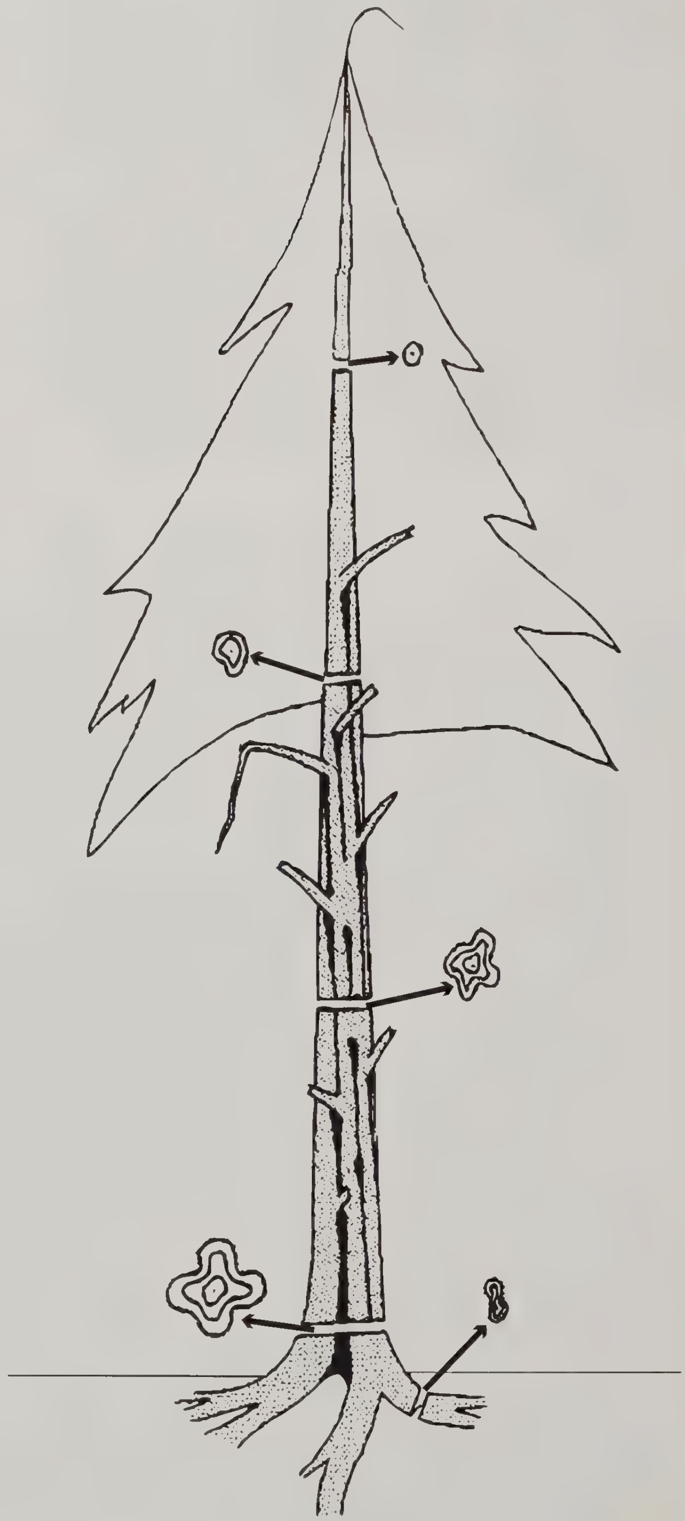


Figure 40. *Hemlock fluting branches disrupt the vertical flow of carbohydrate in the stem causing annual rings to become asymmetrical. Flutes originate beneath decadent branches and extend downward, forming long grooves where other branches are intersected. (Figure and caption from Julin, K.R.; Farr, W.A. 1989. Stem Fluting of Western Hemlock in southeast Alaska).*

Status of Animal Damage

Moose

Alces alces

At many locations across south-central and interior Alaska moose damage hardwoods by browsing stems and wounding tree boles. Repeated, severe browsing of live trees, particularly aspen and willow, results in broken branches, wounds, and stunted malformed stems. Wood decay fungi are known to invade trunk wounds caused by moose.

Snowshoe Hare

Lepus americanus

Bole wounds, terminal and lateral bud damage, and seedling mortality were attributed to browsing by snowshoe hares on hardwoods and conifers in the interior this year. Recovery potential of trees following severe browsing in not known. Studies indicate that stem decay fungi utilize dead branches (killed by hare browsing) as infection courts but bole wounds lack decay. Pronounced resin flow at the wound surface and winter desiccation of wounded tissues likely contribute to the lack of decay with bole wounds.

Recent surveys of pre-commercially thinned white spruce stands near Tok noted damage to seedlings and evidence of "old browse damage" on mature trees. Damage to the mature trees occurred when they were saplings and hare browsing killed the leader. The characteristic angled browse mark is still evident on the dead leader. A lateral branch became dominant following leader death and trees still retain the dead leader but have a pronounced stem crook at the point where the leader died. The dead leaders provided an infection court for heart rot decay by *Phellinus chrysoloma*.

Porcupine

Erethizon dorsatum

Porcupines cause severe damage to Sitka spruce and western hemlock trees in numerous local areas of southeast Alaska. An extensive survey has documented the level of porcupine damage in young-growth stands. Feeding injuries to trees are confined to the known distribution of porcupine. Damage is especially serious on Mitkof Island in southeast Alaska. Other damage has been noted at Thomas Bay, Cleveland Peninsula, Bradfield Canal, Anita Bay and other areas of Etolin Island, Douglas Island, and the Juneau area.

We recently found that porcupines cause very frequent bole wounding on small to medium sized subalpine fir trees near Skagway. Porcupines also damage trees throughout interior Alaska. Bark beetles, including *Ips* spp., have been found infesting the damaged trees.

In southeast Alaska, the feeding behavior of porcupines change as forests develop and trees become larger and older. Porcupines climb smaller trees and kill or cause top-kill by removing bark along the entire bole, or the bole near the top of the tree. As trees become larger, around 40-50 years old, most of the damage is in the form of basal wounding. Most of these larger trees are not killed, but the large basal scars allow fungi to enter the bole and begin to cause wood decay.

The primary ecological consequences of porcupine feeding are: (1) to provide greater diversity of structure and vegetation in young, even-aged conifer stands through mortality and (2) to provide greater levels of heart rot decay by wounding older trees. This latter effect can alter mortality patterns in old forests as trees may often die through bole breakage.

Bear

Ursus arctos
Ursus americanus

Yellow-cedar trees were wounded in the spring by brown bears on Baranof and Chichagof Islands. Brown bears rip the bark away from the lower boles of these trees, apparently to lick the sweet cambium. The majority of yellow-cedar trees in some stands have basal wounds from bear feeding. Other tree species in southeast Alaska are unaffected. Black bears caused injury to the lower boles of white and Lutz spruce and occasionally aspen in the lowland forests of the Kenai Peninsula. Trees with old scars may have associated columns of wood decay.

Appendices

Appendix A
Integrated Pest Management

Integrated pest management (IPM) has been described as a "systems approach to alter pest damage to acceptable levels through a variety of techniques, including predators and parasites, genetically resistant hosts, natural environmental modifications, and when necessary and appropriate, chemical pesticides." Some IPM activities the Alaska Region Forest Health Protection Program is involved in include:

- Funding and technical assistance are provided by the Forest Health Protection program to Alaska Cooperative Extension Service (CES) in a cooperative effort providing pest management information to Alaska residents. The program, which completed its twenty-second season, includes education, research and survey activities, and also provides integrated pest management information concerning urban forestry as well as garden and greenhouse pests. The program is educational in nature and provides the public with a means to learn about pest management in an informal and accessible manner. In 2002, IPM Technicians were located in Fairbanks, Delta Junction, Palmer, Anchorage, Soldotna, and Juneau. The Anchorage office had two seasonal technicians and one full-time Program Coordinator; the remaining locations had one seasonal IPM Technician from May through the end of September. The total recorded client contacts reached more than 7,400. Technicians conducted more than 275 site visits (mostly for tree/community forest issues) and participated in 48 appearances in statewide media: TV news, radio, newspaper, newsletters, and Internet. 915 specimens were examined including insects, invasive and other weeds, diseases, and those associated with abiotic problems. Additionally, the IPM Staff conducted 65 educational programs. More than 50 percent of the IPM Technician activities occurred in the Anchorage Bowl, which is home to over 40 percent of the state population.
- Forest Health Protection funded a statewide invasive plant coordinator position with the Cooperative Extension Service. This resulted in several hundred contacts with individuals and the media regarding the issue of invasive plants. Extensive information was made available to the public through newsletters and the web, including a web-based field guide. See the new Committee for Noxious ands Invasive Plant management (CNIPM) website at: http://www.cnipm.org/index.html
- In 2002 a Weed Scout program was established with the Cooperative Extension Service. This year, the program emphasized the Anchorage area, since as Alaska's major population center; it is the initial site of introduction for many exotic species.
- In cooperation with the USGS and others, a statewide database (Alaska Exotic Plant Clearinghouse) was created as a repository for invasive plant species data. FHP staff provided leadership and funding of this inter-agency project. See the Alaska Geographic Data committee (USGS) website for the methods, field sheets and a database that can be downloaded. http://agdc.usgs.gov/akepic/. Forest Health Protection funded an invasive plant survey in seven communities of northern southeast Alaska with the Sitka Conservation Society.
- Increased tree mortality in Alaska caused by *Ips* spp. has stimulated research on new management tactics utilizing semiochemicals such as pheromones and tree bark volatiles to minimize damage from bark beetles. As part of this effort, trapping studies were conducted on the Kenai Peninsula and in interior Alaska (Tok) in 2002 to determine the effect of a specific compound (conophthorin) as an attractant or repellent of *I. perturbatus.*
- The genetics of spruce aphid infestations will be studied in southeast Alaska by doing "fingerprint" analysis of separated populations throughout coastal Alaska. Karen Armstrong, of Lincoln University, Canterbury, Australia, will assist in the chemical analysis.
- FHP staff is cooperating with the University of Minnesota to help determine the ratios and biochemical structures of pheromones used by the pine engraver, *Ips pini*, bark beetle to aggregate in trees in southeast Alaska. This work can lead to development of semio-chemical treatment options to minimize damage from this bark beetle.

- Yellow-cedar wood is often devalued because of dark staining. Some evidence suggests that insects are involved in introducing a dark-staining fungus. FHP staff is working to identify the staining processes and effects this may have on the value of this wood. To date, isolations have revealed Sporidesmium sp. and Phialophora melinii as two of the most common dark fungi.
- FHP staff have sketch-mapped approximately 500,000 acres of dead yellow-cedar throughout southeast Alaska. Understanding the spatial context of this decline is important to understanding its potential causes and how to manage the resource. Efforts are currently underway to develop detection and mapping techniques beyond the current sketch mapping method. Several ways of obtaining this information are being explored, using image analysis of various image types and scales and GIS analysis.
- In 2002, a project was initiated to clarify the role of soils, hydrology, and temperature as possible causes of yellow-cedar decline. Sixty-five monitoring plots were established in two yellow-cedar decline areas at Poison Cove and Goose Cove, southeast Alaska. Instruments were deployed to measure and record soil temperature in the tree-rooting zone every four hours throughout the year. We also made physical measurements of soil hydrology at these same locations four times during 2002. The physical properties and chemistry of these soils are also under investigation. This will lead to a better understanding of the correlations of soils, hydrology, and temperature with the presence and extent of yellow-cedar decline.
- The spread and intensification of hemlock dwarf mistletoe is currently under study in even-aged stands, stands that have received different selective harvest treatments, and stands that experienced extensive wind damage in the 1880s. Results show a substantial difference in mistletoe levels by stand management or disturbance history. This indicates a wide range of disease severity that can be related to simple measures of inoculum load at the time of harvest. Distances and intensities of spread are being determined to provide information that will allow managers to design appropriate harvesting scenarios in relation to expected disease levels.

Appendix B
Submitting Insects and Diseases for Identification

The following procedures for the collection and shipment of specimens should be used for submitting samples to specialists:

I. **Specimen collection**:

1. Adequate material should be collected
2. Adequate information should be noted, including the following:
   a. Location of collection
   b. Date of collection
   c. Who collected the specimen
   d. Host description (species, age, condition, # of affected plants)
   e. Description of area (e.g., old or young forest, bog, urban);
   f. Unusual conditions (e.g., frost, poor soil drainage, misapplication of fertilizers or pesticides?).
3. Personal opinion of the cause of the problem is very helpful.

II. **Shipment of specimens**:

1. General: Pack specimens in such a manner to protect against breakage.
2. Insects: If sent through the mail, pack so that they withstand rough treatment.
   a. Larvae and other soft-bodied insects should be shipped in small screw-top vials or bottles containing at least 70 percent isopropyl (rubbing) alcohol and 30 percent water. Make certain the bottles are sealed well. Include in each vial adequate information, or a code, relating the sample to the written description and information. Labels inserted in the vial should be written on with pencil or India ink. Do not use a ballpoint pen, as the ink is not permanent.
   b. Pupae and hard-bodied insects may be shipped either in alcohol or in small boxes. Specimens should be placed between layers of tissue paper in the shipping boxes. Pack carefully and make certain that there is very little movement of material within the box. Do not pack insects in cotton.
3. Needle or foliage diseases: Do not ship in plastic bags. Sprinkle lightly with water before wrapping in newspaper. Pack carefully and make sure that there is very little movement of material within the box. Include the above collection information. For spruce and other conifers, include a description of whether current year's-needles, last-year's needles, or old-needles are attacked.
4. Mushrooms and conks (bracket fungi): Do not ship in plastic bags. Either pack and ship immediately, or first air dry and then pack. To pack, wrap specimens in dry newspaper and pack into a shipping box with more newspaper. If on wood, include some of the decayed wood. Be sure to include all collection information.

III. **Shipping**:

1. Ship as quickly as possible, especially if specimens are fresh and not air-dried. If samples cannot be shipped rapidly, then store in a refrigerator.
2. Include return address inside shipping box.
3. Mark on outside: "Fragile: Insect-disease specimens enclosed. For scientific purposes only. No commercial value."

Appendix C
Biological Evaluations, Technical Reports, & Publications

Boughton, J.L.; Shephard, M.E.; 2002. Invasive Plants in Alaska—A Chance to Catch the Problem Early. Society of American Foresters, Western Forester. 47(3); 12-13.

Burnside, R. 2001. Forest health update--A decade of spruce beetle activity in Alaska. Society of American Foresters, Western Forester. 46(3): 6-7

Deal, R.L.; Tappeiner, J.C.; Hennon, P.E. 2002. Developing silvicultural systems based on partial cutting in western hemlock-Sitka spruce stands of southeast Alaska. Forestry. 75: 425-431.

Green, D.W.; McDonald, K.A.; Hennon, P.E.; Evans, J.W.; Stevens, J. H. 2002. Flexural properties of salvaged dead yellow-cedar. J. For. Prod. 52(1): 81-88.

Holsten, E.H. 2001. The Larch Sawfly. USDA For. Serv. Alaska Region Leaflet R10-TP-101. 8p.

Holsten, E.H. 2001. Birch Leaf Miner. USDA For. Serv. Alaska Region Leaflet R10-TP-105. 8p.

Holsten, E.H., Burnside, R.E., Seybold, S.J. 2001. Verbenone Interrupts the Response to Aggregation Pheromone in the Northern Spruce Engraver, Ips perturbatus (Coleoptera: Scolytidae), in South-Central and Interior Alaska. Journal of the Entomological Society of British Columbia 98: 251-256.

Holsten, E.H., Hennon, P.E., Trummer, L.M., Schultz, M.E. 2002. Insects and Diseases of Alaskan Forests. United States Department of Agriculture, Forest Service, Alaska Region. R10-TP-87. 242p.

Holsten, E.H.; Webb, W.; Shea, P.J.; R.A. Werner. 2002. Release Rates of Methylcyclohexenone and Verbenone from Bubble Cap and Bead Releasers Under Field Conditions Suitable for the Management of Bark Beetles in California, Oregon, and Alaska. Portland, OR. USDA For. Service, Pacific Northwest Research Station research paper, PNW-RP-544. 21 pp.

Lowell, E.C. and Trummer, L.M. 2002. Assessing the Effect of Decay and Stain on Utilization of Alaska's Paper Birch Resource. In: Proceedings of the Interior Alaska Forest Products Conference 2001, May 7-9, 2001, Fairbanks, Alaska.

Schultz, M.E. 2002. Yakutat Forelands: 2001 Blowdown. Biological Evaluation. 11p.

Trummer, L. and Holsten, E. 2002. Common Forest Insects and Diseases in South-central Alaska (laminated card set). USDA Forest Service, Alaska Region, R10-TP-108. 41 p.

Werner, R.A., and E.H. Holsten. 2002. Use of Semiochemicals of Secondary Bark Beetles to Disrupt Spruce Beetle Attraction and Survival in Alaska. Portland, OR. USDA For. Service, Pacific Northwest Research Station research paper, PNW-RP-541. 11 pp.

Wittwer, D.; Matthews, K.; Zogas, K.; Burnside, R.; Holsten, E.; Schultz, M.; Trummer, L. and Hennon, P. 2002. Forest insect and disease conditions in Alaska-2001. USDA Forest Service, Alaska Region, FHP. Gen. Tech. Rep. R10-TP-102. 66 p.

Zogas, K. and E.H. Holsten. 2002 (March). Bibliography/Alaska Region Forest Health Protection. USDA Forest Service, Alaska Region, FHP Technical Report R10-TP-107. 136 p.

Zogas, K. 2002 Spruce Beetle Activity: Pedro Bay Village. Biological Evaluation. 14 p.

Appendix D
World Wide Web Links

Forest insect and disease survey information and general forest health information:

http://www.fs.fed.us/r10/spf/fhp

USDA Forest Service, State & Private Forestry, Forest Health Protection site for Alaska with information on Alaskan insects and diseases, bibliography listing, and links to other Forest Health sites. The site presents a program overview, personnel information, current forest insect and disease conditions throughout the state, forest insect and disease biology, control, impacts, Sbexpert software and other Forest Health issues.

http://www.dnr.state.ak.us/forestry/index.htm

The site is an Alaska Department of Natural Resources, Division of Forestry home page. Information is available on several of Forestry's programs, including forest health and forest insect surveys. A link is provided on the home page for accessing forest health and insect survey information and to send an e-mail message.

http://agdc.usgs.gov

The Alaska Geospatial Data Clearinghouse is a component of the National Spatial Data Infrastructure (NSDI). The Clearinghouse provides a pathway to find geospatial referenced data and associated metadata for Alaska. The site is a link to data available from a multiple of federal, state and local agencies. The U.S. Geological Survey, EROS field office in Anchorage currently administers the site. From this website the Forest Health Monitoring Clearinghouse and the State of Alaska, DNR Geographic Data Clearinghouse can be reached.

http://agdc.usgs.gov/data/projects/fhm

The Forest Health Monitoring Clearinghouse provides special resource databases of forest health related information to land managers, scientists, and the general public. Statewide data layers are available for downloading, including Vegetation/land cover, ECOMAP and Ecoregions, Wetlands Inventory, Timber Harvest and other disturbances, Yearly Insect and Disease Damage, Fire History, Fire Protection Zones, Fire Management Boundaries, Fire Fuels Models, Land Status/Ownership, Elevation, Hydrography, Soils, and Permafrost.

http://www.asgdc.state.ak.us

The State of Alaska, Department of Natural Resources' Geographic Data Clearinghouse serves as a repository for state geographic data layers and metadata. Data available on this site includes, land status, transportation, physical boundaries, cultural, biologic, etc. Maps, other state resource information (e.g., forest pest damage surveys, Exxon Valdez restoration data, CIIMMS) and links to other agencies, municipalities and boroughs are found here.

http://www.fs.fed.us/r6/nr/fid/wid.shtml

This site contains a valuable online catalog of information on Western Forest Insects and Diseases located on the USDA Forest Service Oregon/Washington Home-page. For specific information on the Spruce Beetle, the online version of the Forest Insect & Disease Leaflet #127 on the Spruce Beetle can be found at www.na.fs.fed.us/spfo/pubs/fidls/sprucebeetle/sprucebeetle.htm. This publication has been recently revised nationally by the U.S. Forest Service and is available in brochure form.

http://www.invasivespecies.gov/geog/state/ak.shtml

A gateway to Federal and State invasive species activities and programs. This link is the State of Alaska's web site for national biological Information on invasive species. Databases on invasive plants and a list of regulated noxious weeds can be found.

In cooperation with the USGS and others, a statewide database (Alaska Exotic Plant Clearinghouse) was created as a place where invasive plant species data can be stored. See the Alaska Geographic Data committee (USGS) website for the methods, field sheets and a downloadable database. http://agdc.usgs.gov/akepic/

http://www.cnipm.org/index.html

This site was developed by the Committee for Noxious and Invasive Plants Management in Alaska (CNIPM). Its' goal is to heighten the awareness of the problems associated with non-native invasive plants and to bring about greater statewide coordination, cooperation and action to halt the introduction and spread of undesirable plants.

http://www.fs.fed.us/r10/spf/fhp/hazard/

This web page was designed to provide managers with basic information about hazard trees. The information is presented with a logical flow from hazard tree theory to recognition, evaluation, and lastly prevention.

Appendix E
Information Available From Statewide Aerial Surveys

Each year, forest damage surveys are conducted over approximately 30 million acres. This annual survey is a cooperative effort between USDA Forest Service, State and Private Forestry, Forest Health Protection (S&PF/FHP) and State of Alaska, Department of Natural Resources, Division of Forestry (AKDNR/DOF) forest health staffs to assess general forest conditions on Alaska's 129 million acres of forested area. About 25 percent of Alaska's forested area is covered each summer using fixed-wing aircraft and trained observers to prepare a set of sketch-maps depicting the extent (polygons) of various types of forest damage including recent bark beetle mortality, various hardwood and conifer defoliation, and abiotic damage such as yellow-cedar decline. A number of other damage types are noted including flooding, wind damage, and landslide areas during the survey. The extent of many significant forest tree diseases, such as stem and root decays, are not estimated from aerial surveys since this damage is not visible from aerial surveys as compared to the pronounced red topped crowns of bark beetle-killed trees.

Forest damage information has traditionally been sketched on 1:250,000 scale USGS quadrangle maps at a relatively small scale. For example, at this scale one inch would equal approximately 4 miles distance on the ground. When cooperators request specialized surveys, larger scale maps are sometimes used for specific areas to provide more detailed assessments. A digital sketch mapping system, augmented with paper maps, has been used in recent years. This system displays the sketch mapper's location via GPS input and allows the observer to zoom to various display scales. The many advantages of using the digital sketch map system include more accurate and resolute damage polygon placement and a shorter turnaround time for processing and reporting data.

Due to the short Alaska summers, long distances required, high airplane rental costs, and the short time frame when the common pest damage signs and tree symptoms are most evident (i.e., usually only during July and August), sketch mappers must strike a balance to efficiently cover the highest priority areas with available personnel schedules and funding.

Prior to the annual statewide forest conditions survey, letters are sent to various state and federal agency and other landowner partners for survey nominations. The federal and state biological technicians and entomologists decide which areas are the highest priorities from the nominations. In addition, areas are selected where several years' data are collected to establish trends from the year-to-year mapping efforts. In this way, general damage trend information is assembled for the most significant pests and compiled in this annual Conditions Report. The sketch map information is digitized and put into a computerized Geographic Information System (GIS) for more permanent storage and retrieval by users.

Information listed in this Appendix is a sample of the types of products that can be prepared from the statewide surveys and GIS databases that are available. Due to the relatively high cost of mass-producing hard copy materials from the survey data, including colored maps, a number of other map products that are available have not been included with this report. In addition, maps which show the general extent of forest insect damage from 2000 and previous statewide aerial surveys, landowner boundaries, and other types of map and digital data can be made available in various formats depending on the resources available to the user:

Submit data and map information requests to:

Roger Burnside, Entomologist
State of Alaska Department of Natural Resources
Division of Forestry Central Office, Resource Section
550 W. 7th Avenue, Suite 1450
Anchorage, AK 99501-3566
Phone: (907) 269 8460
Fax: (907) 269-8902
E-mail: rogerb@dnr.state.ak.us

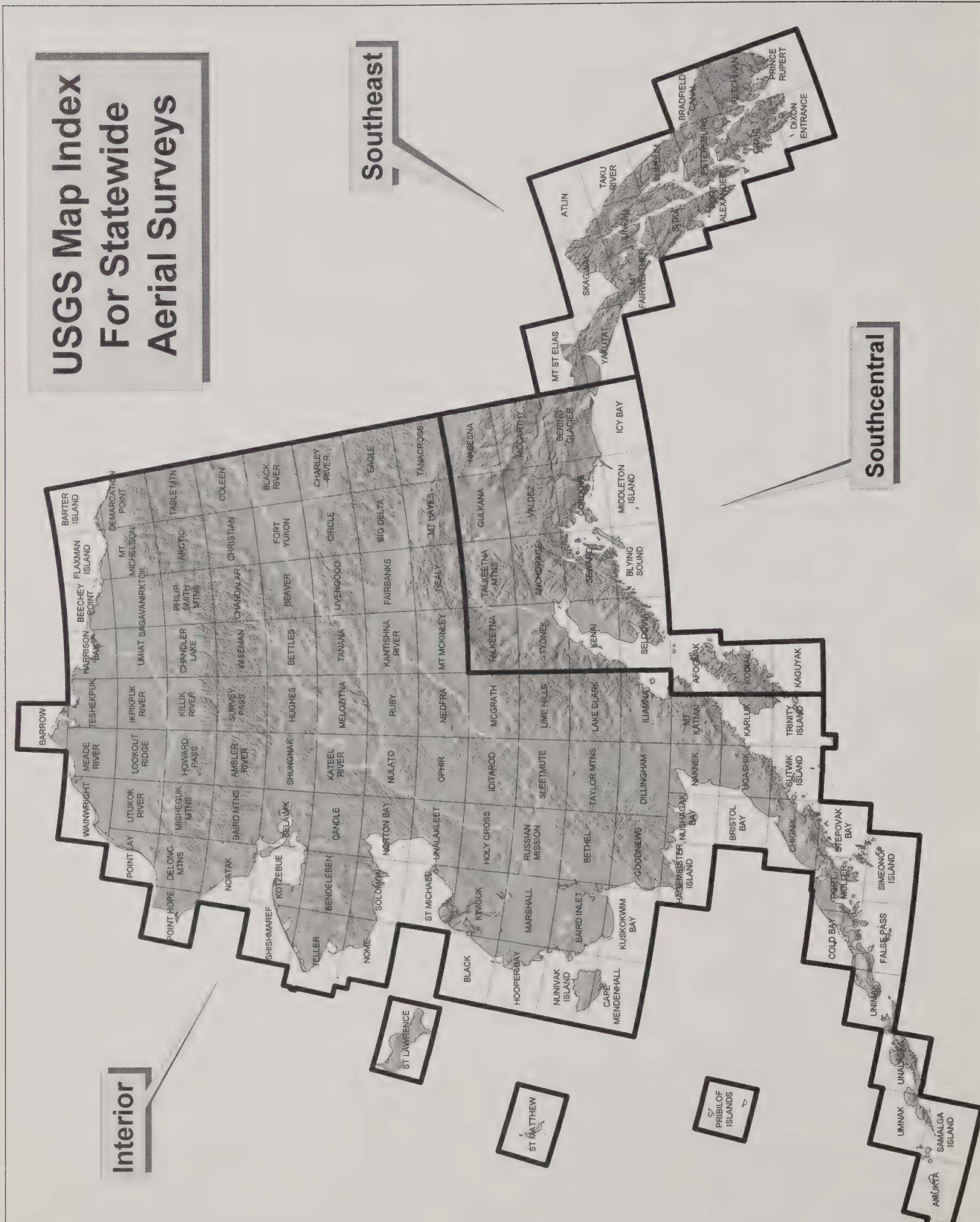
Dustin Wittwer, Bio-technician
USDA Forest Service, State &Private Forestry
Forest Health Protection
2770 Sherwood Lane, Suite 2A
Juneau, AK 99801
Phone: (907) 586-7971
Fax: (907) 586-7848
E-mail: dwittwer@fs.fed.us

Map information included in this report: "Forest Insect And Disease Conditions In Alaska -2002"

- Aerial Detection Survey, Significant Pest Activity, 11x17 in. format, depicting spruce beetle, black-headed budworm, aspen leaf miner, spruce aphid, birch leaf miner, and birch leaf roller (color; showing enhanced representation of damage areas).
- 2002 Alaska Forest Damage Surveys Flight Lines and Major Alaska Landownership Blocks (includes table listing acres surveyed by landowner based on flight lines flown for the 2002 aerial surveys).
- Kenai Peninsula Region Spruce Beetle Activity 1997-2002, 8 x 11 in. format, depicting sequential year-by-year spruce beetle activity in south-central Alaska, including the Kenai Peninsula, Cook Inlet area to Anchorage & Talkeetna (includes vegetation base layer).
- The Spruce Beetle Outbreak: Year 2002, 8 x 11 in. format, depicting 2002 damage in red and prior damage, 1989-2001 in yellow (includes color shaded relief base showing extent of forest landscape and sample photos of spruce beetle impact).
- Southeast Alaska Cedar Decline 2002 Aerial Detection Surveys, 8 x 11 in. format, depicting cumulative Alaska yellow-cedar decline over several years (includes a sample photo of cedar decline. Forested areas are delineated with color shaded relief background)
- Birch Leaf Miner, depicting birch defoliation in the Anchorage area. Intensity is shown as high, medium or low.
- Yakutat 2002 blowdown, depicting a blowdown event in 2002, mostly north east of Yakutat.
- Skagway fir beetle mortality, fir mortality north a Skagway presumably caused by a bark beetle.

Map and GIS Products Available Upon Request:

- Digital data file of 2002 forest damage coverage in ArcInfo cover or ArcView shape file (ESRI, Inc.) format. GIS data files are available at the following URL: http://agdc.usgs.gov/data/projects/fhm/.
- An electronic version of this report, including maps and images, will be available at the Alaska USFS, State & Private Forestry, Forest Health Protection web site (URL: http://www.fs.fed.us/r10/spf/fhp
- Cumulative forest damage or specific-purpose damage maps prepared from AK/DOF or AK USFS, S&PF, FHP geographic information system database.
- Forest Insect & Disease Conditions in Alaska CD-ROM (includes most of digital forest damage coverage in the AKDNR/DOF database in viewable formats and a copy of the 2002 Alaska Forest Insect & Disease Conditions Report in .pdf format; a fee may be assessed depending on availability of copies and amount of data required for the project).


USGS Map Index
For Statewide
Aerial Surveys
Southeast
Southcentral
Interior

Quadrangle Areas Flown During 2002 Statewide Aerial Surveys:

*Quads without insect damage reported for 2002 are marked with an asterisk.

South-central Alaska

Anchorage
Cordova
Kenai
Mccarthy
Nabesna*
Seldovia
Seward
Talkeetna
Talkeetna Mtns*
Tyonek*
Valdez

Southeast Alaska

Atlin*
Bradfield Canal
Craig
Dixon Entrance
Juneau
Ketchikan
Mt Fairweather
Petersburg
Port Alexander
Sitka
Skagway
Sumdum
Taku River
Yakutat

Interior Alaska

Ambler River
Baird Mtns
Bendeleben*
Bettles*
Big Delta
Black River
Beaver
Charley River
Circle
Coleen*
Christian*
Dillingham
Eagle*
Fairbanks
Fort Yukon
Healy
Holy Cross*
Hughes
Iliamna
Kantishna River
Kotzebue*
Lake Clark*
Lime Hills*
Livengood
Mcgrath
Medfra
Melozitna*
Mt Hayes
Mt Mckinley
Mt St Elias*
Naknek*
Noatak*
Norton Bay*
Nushagak Bay*
Ruby*
Russian Mission*
Shungnak*
Selawik*
Sleetmute
Solomon
Survey Pass*
Tanana
Taylor Mtns*
Tanacross*
Unalakleet

Tree damage codes used in 1989-2002 aerial surveys and GIS map products.

* The codes used for 2002 aerial surveys and GIS maps are marked with an asterisk.

ALB	Aspen leaf blight
ALD	Alder defoliation
ALM*	Aspen Leaf Miner
ALR*	Alder leaf roller
ASD	Aspen defoliation
ASF	Alder sawfly
BAP	Birch aphid
BHB*	Black-headed budworm
BHS	BHB/HSF
BID	Birch defoliation
BLM*	Birch Leaf Miner
BLR*	Birch leaf roller
BSB	BHB/SPB
CDL*	Cedar decline
CLB*	Cottonwood leaf beetle
CLM	Cottonwood leaf miner
CLR*	Cottonwood leaf roller
COD	Conifer defoliation
CTB	Conifer top breakage
CWD*	Cottonwood defoliation
CWW	CWD and WID
FIR	Fire damage*
FLO*	Flooding/high-water damage
FRB*	Sub Alpine Fur Beetle
HCK*	Hemlock canker
HLO	Hemlock looper
HSF*	Hemlock sawfly
HTB	Hardwood top breakage
HWD	Hardwood defoliation
IPB	Ips engraver and Spruce beetle
IPS*	Ips engraver beetle
LAB*	Larch beetle
LAS	Larch sawfly
LAT*	Large aspen tortrix
OUT	Out (island of no damage)
POD*	Porcupine damage
SBM	Spruce/Larch bud moth
SBR	Spruce broom rust
SBW*	Spruce budworm
SLD*	Landslide/Avalanche
SMB	Spear-marked black moth
SNA*	Spruce needle aphid
SNC*	Spruce needle cast
SNR	Spruce needle rust
SPA	Spruce aphid
SPB*	Spruce beetle
SPC	SPB and CLB
WID*	Willow defoliation
WIR	Willow Rust
WLM*	Willow Leaf blotch Miner
WNT	Winter damage
WTH*	Windthrow/Blowdown

Note: In the digital data all insect and disease activity has an intensity attribute. Agents typically resulting in defoliation or discoloration are attributed with a High, Medium or Low. Agents typically resulting in mortality are attributed with a tree per acre estimate. Digital data and metadata can be found at the following URLs: http://agdc.usgs.gov/data/projects/fhm/

Or

http://www.fs.fed.us/r10/spf/fhp

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